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BRIEFLY TOLD.

DEATH OF ROBERT MCCOSKRY GRAHAM.—We are called upon to announce the death of Mr. Robert McCoskry Graham, President of the Equitable Gas Light Company, of this city, and also President of the Utica (N. Y.) Equitable Gas and Electric Light Company. Mr. Graham died at his home (No. 125 E. 52d street) in this city, on the afternoon of Saturday, Dec. 13, after an illness of four days, which terminated fatally with a suddenness that was appalling to his family. Deceased was born in New York city, on September 28, 1830, and, if we mistake not, his father was also native born to the city. His earlier studies were carried on in our local schools, and were completed by a three year's higher course abroad. Having attained his 31st year he was united in marriage to Miss Cornelia Sherman, daughter of Wooster Sherman, President of the Watertown (N. Y.) National Bank. Left a widower in 1885, in 1887 we find him married to Miss Elia Ward, a daughter of J. H. H. Ward, of this city, who, with two sons and four daughters, are the surviving members of his immediate family. One of the sons, Harold Graham, is Secretary and Treasurer of the Utica Equitable Company. The connection of deceased with the gas industry was chiefly in an executive capacity, and if his successful conduct of the Equitable Company's fortunes in this city is to be accepted as evidence of his capacity, he must be acknowledged as having been the right man in the right place. Mr. Graham was identified with many gas enterprises that had been put forward by either the syndicate or individuals controlling or connected with the Equitable Company of the United States, and his services to them are worthy of continued remembrance by them. Suave, alert, dignified and well poised, Mr. Graham was always a favorite with his business associates and with a very wide circle of personal friends. He was perhaps one of the best known club men in New York city, and, better still, had the respect, confidence and affection of those bound to him by the family tie. If we mistake not he served for one or two terms as Treasurer of Long Island City, L. I. The funeral services were celebrated on the morning of Tuesday last, at the Church of the Transfiguration, and the interment was made in Greenwood.

SOME PLAIN FIGURES FROM MILWAUKEE, WIS.—Certain speculators are buttonholing the authorities of Milwaukee, Wis., on every possible occasion, with the desire to impress on the aforesaid authorities that the residents of the city are suffering from the delay that the speculators are experiencing in receiving official notification that their application for a franchise for the right to manufacture and distribute fuel gas in the city has been acceded to. As nearly as we can make out, Messrs. Flanders and Mariner are the ostensible proprietors of a scheme to supply fuel gas to the city, on a large scale, and they have made the usual nitrogenous argument in support of the virtues of the patent system under which they propose to work—in the Milwaukee instance we believe it is on the cards that the Jackson (Mich.) type of process and apparatus is the one favored by Flanders and Mariner. It is also our belief that Flanders and Mariner say they, "or their assigns," will reap good profits and tickle the citizens if they are allowed to distribute their gas at a price not to exceed 50 cents per 1,000 cubic feet; further, Messrs. F. and M. assure the authorities that the Jackson gas is much superior in heating value, foot for foot, to that distributed by the local Gas Company. At

this juncture it might be well to remark that the local Gas Company enjoys, after due allowance for the circumstances surrounding its location and position, the distinction that it will shortly sell its product—for heating, cooking and power purposes, at any rate—at the lowest rate that obtains in this country; for we have already printed in the JOURNAL (November 24, p. 731) that on and after January 1st the Milwaukee housewife, the Milwaukee artisan, or the Milwaukee gas engine user, respectively, may cook the dinner, heat his furnace, or drive the works with a rich illuminating gas, to be charged for at the uniform rate of 80 cents per 1,000 cubic feet. Under these circumstances one would naturally suppose that fuel gas speculators, particularly those who favor fuel gas of the dilute nitrogenous type, would fight shy of Milwaukee; but with a persistence worthy of a better cause—unless it be that F. and M. are merely acting as agents for other parties, and as such have only a "commission interest" in securing the bill or franchise, said commission to be contingent on a successful issue of their efforts—F. and M. would not be cast down or balked by the obstacle of a fuel gas minus the nitrogen at a rate confessedly cheap. The City Council was not in any sense enthusiastic over the proposition advanced by the commission agents; it would not extend its arms in open welcome; it desired proof of the statements so extravagantly based, for it had word of such things before.

Nothing daunted, F. & M. ordered up a quantity, "in bags," of the Jackson article, and the Council deputized its Judiciary Committee to preside over or conduct an inquest in respect to the relative heating merits of equal quantities of gas from the mains of the Milwaukee Gas Light Company and from the bags that were imported from Jackson, Mich.

On Nov. 24 gas was turned on from the Jackson bags under a kettle that contained 5 lbs. of water, and it was reported that the water, the initial temperature of which was 51½° F., had been raised to 83½° F. in 13 minutes, with a consumption of 7-10ths of a cubic foot of the gas, and a development of 228.5 heat units—the Judiciary Committee, it might be observed, was not holding an inquest at that time. Then the welkin rang—that is, F. & M.'s welkin. Nor did the ringing cease when the Milwaukee Company tacitly admitted that it could not do so well.

Later on, however, the "official practical test" was made, with the following results: The Milwaukee Gas Company's product raised 5 lbs. of water, from an initial temperature of 44° F., to 210° F. in the space of 14 minutes, the gas consumption being 2.25 cubic feet, the heat unit development being 369. From the time that the Jackson bags were opened until the water treated began to sing, 20 minutes of time were taken up, 4.17 cubic feet of gas were consumed, and 5 lbs. of water were raised from an initial temperature of 42° to 208°. The welkin now of F. & M. is somewhat overcast, and if their Christmas dinner depends on that commission we fear that subsequent nightmare is not to be their portion.

These figures ought to show that, in comparison with the Milwaukee Company's product at 80 cents per M., the Jackson article would be dear at 30 cents. And so the verdict is likely to be, if the Judiciary Committee acts in accordance with reason.

A JUST DECISION.—THE LACLEDE COMPANY SUCCESSFUL.—Some months since we noted in the JOURNAL that the Municipal Assembly of St. Louis had passed a mandatory ordinance decreeing that the Laclede Gas Light Company should not charge in excess of 90 cents per 1,000 cubic feet for gas sold by it, that Mayor Noonan had vetoed the ordinance, that the Assembly had re-enacted the ordinance over the veto, that it had been attempted by the authorities to enforce the ordinance, and that an estoppel in the latter attempt had been made by the Company, which sued out an injunction restraining the city from proceeding until the Supreme Court had passed on the legality of the ordinance. In the meanwhile, to secure a better understanding of the case, it should be explained that the old St. Louis Gas Light Company, in 1886, on condition that it accepted an ordinance regulating its right to charge but $1.50 per 1,000 for gas from the time it accepted the ordinance until 1890, and but $1.25 from January, 1890, until January 1920, secured an extension of its charter for 25 years. In proper time the Company filed its acceptance of the agreement, on behalf of—"itself, its successors, assigns," etc.—this ordinance bearing the number 13,494. In the course of business complications the Laclede Company succeeded to the St. Louis Company's property, estates, franchises, etc., by purchase, and also filed a written acceptance of the obligations imposed by ordinance 13,494. Some time afterwards the Laclede Company, which succeeded to all the rights and privileges of the Companies that had had an independent existence in St. Louis, voluntarily reduced the gas rate to $1.18¾ per 1,000 net, and later on the city passed the 90 cent act. It might be more in line with the exact truth to state that the present decision of the Supreme Court was prompted by City Counselor Bell, who asked the Supreme Court to order the Laclede Company to show cause why the 90 cent ordinance should not be enforced. With that understanding we herewith submit the following abstract, of the decision, as forwarded by an esteemed correspondent, adding the promise that when the text of the decision is received we shall place the same before our readers—the number of the 90 cent ordinance is 15,482: "The points at issue between the contestants in the present litigation were four in number: (1) That the St. Louis Gas Light Company had no power to contract with the city as to matters necessarily extending beyond the limit of its chartered existence; (2) that ordinance 13,494 did not exempt the respondent Company from regulations by the city of the price of gas; (3) that there is nothing in the charter of the respondent Company which forbids the reduction by the city of the price of gas after the first day of January, 1890; and (4) that even if that ordinance and the acceptance thereof may be regarded as constituting a contract, yet that such contract, if it has the effect claimed for it by the respondent, was beyond the power of the city to make, being nothing less than a futile attempt to barter away 'a police governmental power affecting the health and welfare of the people of St. Louis.'

"As to the first point, Judge Sherwood holds that a corporation has the right to convey real, personal or other property under all and the same circumstances as the individual; that the ordinance clearly contemplated that the rights granted to the original Company would be by that Company granted to its successor, and that when its property was transferred to another Company the contract became a contract between the city and the transferee. As to the second point, he holds that ordinance 13,494 does not warrant the construction placed upon it by the counsel for relator, being a valid contract between the city and the St. Louis Company. In answer to the third point the Judge quotes the provisions of the charter granted to the Laclede Gas Company, March 2, 1857, which gave the Company authority to lay pipes, make and vend gas in the city of St. Louis, and made no limitation as to the price to be charged for its product. 'It is not open to doubt or dispute that the power to make and vend gas carries with it as an inevitable incident the right to fix the price of gas thus made and sold. No other conclusion can be drawn from the premises. A sale implies a price. Whatsoever the law necessarily implies in a statute or in a contract is as much part and parcel thereof as if expressly stated therein. So that, by the terms of the charter of the respondent Company, its right to fix the price of its product was as much a part of its charter as if it had been in terms set forth in the original act of incorporation. But if a price had thus been set forth, no one familiar with constitutional principles but would at once deny that the right to contract for the sale of gas at such price could anywise be impaired.'

"The answer to the fourth point may be summed up as follows: If, as claimed by the relator, the power to regulate the price of gas having been granted by the State to the city as a police governmental power which could not be bartered away by the State, then the charter of the respondent Company was valueless when it came from the hands of its grantor.

"'It is not to be doubted that there is a limit to the power of the Legislature to tie the hands of subsequent Legislatures in respect to the exercise of what is termed the 'police power.' But certainly there is a limit in this regard over which Legislatures and municipalities cannot pass; they cannot, in the exercise of assumed police powers, violate charter contracts and overthrow vested rights.'

"In conclusion, Judge Sherwood says: 'As a summary of our views herein, we consequently hold—(1.) That the charter of the respondent Company was a contract between it and the State which authorized it to fix the price of gas which it should manufacture, and which price could not be diminished by subsequent legislative action, whether State or municipal. (2.) That ordinance 13,494, when accepted as therein provided by the St. Louis Gas Light Company, constituted a valid contract between that Company and the city of St. Louis. (3.) That by the subsequent transfer by the original Company of its property rights, franchises, etc., to the respondent Company, and by written acceptance, etc., of ordinance 13,494 by that Company, a like valid contract was formed between the city and that Company; (4) which contract was beyond the power of the city to impair or in any manner affect by ordinance 15,482. We therefore shall deny the peremptory writ."

THE Iowa Fuel and Power Company, of Council Bluffs, Ia., is "drawing" out estimates from contractors on its proposed fuel gas plant.

The Artificial Light of the Future.

[A paper read by Mr. Edward L. Nichols, before the N. Y. Electric Club.]

The growth of electric lighting forms one of the most brilliant chapters in the history of invention. The record is one of which the electrician has reason to be proud. It is a record of advance following advance in our means of generating current and of transmitting it. It is the record of the evolution of the arc lamp from the first crude forms to the perfectly regulated lamp of to-day. It is the record of the development of the incandescent lamp. Throughout it all we note with wonder that the perfecting of 10,000 details of construction has gone hand in hand with ever diminishing cost of production.

As we review the history of the electric light, however, we find that

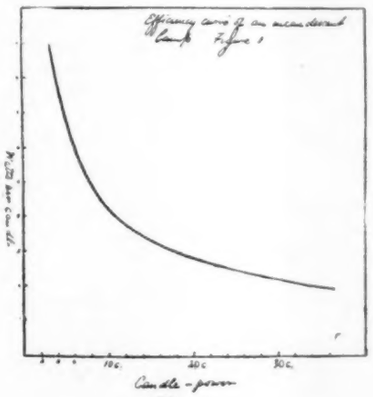

Fig. 1.

in two respects there is less cause for congratulation. When we come to consider the quality of the light produced and the efficiency of the apparatus as a light-making machine, we find that the incandescent lamp of to day produces the same quality of light which the earliest examples of its type were capable of giving. We find, however, that its light differs but little from that obtained by burning oil and gas, which, in turn, in spite of all the improvements which have marked the growth of artificial illumination, is almost the same in quality as that which the Eskimo obtains from the crude blubber of the whale, or which the dweller in the log cabin on the frontier may get from his home made tallow dip.

It is true that the efficiency of the incandescent lamp has gradually

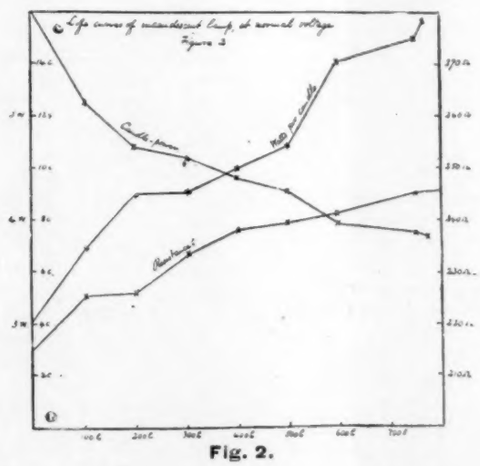

Fig. 2.

risen from 5 to 3 watts per candle; but those who have occasion to trace the discouraging life curves of such lamps know how little real progress the change implies. We start a well manufactured lamp at any temperature we please, provided that we do not pass a certain limit, beyond which the life of the lamp would be too seriously curtailed. The initial efficiency may be made as large as we please, within that limit; but it is only a question of a few days or hours when the lamp will have dropped to the dead level of mediocrity—the 5-watt level which seems to mark the confines of permanency in the case of incandescent carbon.

When we take a lamp and raise its electromotive force step by step, measuring the current, voltage, and candle power at each stage of the experiment, and plot the curve which expresses the relation between the energy required and the light produced, we are gratified at the marked rise in efficiency which follows each slight increase in temperature of the filament (Fig. 1). That rise of temperature, however, means shortening of the life of the carbons, as is well known. Unfortunately, rise of temperature means much more than that. I will venture to show you a few life curves recently obtained in the laboratory of Cornell University. These curves enable us to see at a glance what happens during the curtailed existence of a lamp which is forced to undue brilliancy.

In the first instance a lamp was started at the candle power indicated by the maker, and was held at constant voltage by means of the current from a storage battery. The initial candle power was 16, which was obtained at the expenditure of 3.015 watts per candle. Measurements of electromotive force and current were made at intervals of about 10 hours during the 800 hours that the lamp lasted. The candle power was redetermined at intervals of about 100 hours. The voltage never rose more than 65 volts above its initial value, and then only for a short time. The average electromotive force of the entire run was 0.40 volt below the initial value. The record of this lamp is contained in Fig. 2. It represents an individual case and not the average obtained from many lamps, but it is typical of the results which have been obtained with many. The characteristic features are rapid, followed by slower, falling off in candle power, the decrement amounting finally to more than 50 per cent.; and rapid, followed by slower, falling off of efficiency, to a final value of 5.75 watts per candle. These changes were accompanied by continuous and marked increase in the resistance of the filament.

Is it be asked whether this individual case represents a state of affairs common to all incandescent lamps. I can only say that in my experience, which is certainly much less extensive than that of some others, I have known of no class of lamps the performance of which did not agree approximately with that indicated by these curves.

This falling off in candle power exhibited by lamps maintained at constant voltage can be met by a procedure not easily applicable perhaps in commercial work, but readily carried out where the object in view is simply to study the behavior of the lamp under usual conditions. The method consists in raising the electromotive force at short intervals of time by amounts sufficient to restore the candle power to its normal value.

The results of such an experiment performed upon a lamp precisely similar to that from which the curves in Fig. 2 were obtained are depicted graphically in Fig. 3. Under this treatment the life of the lamp in question was not quite 100 hours. The total rise in electromotive

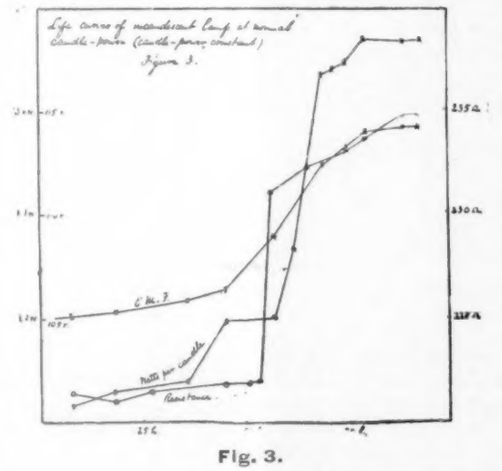

Fig. 3.

force during the test amounted to about 9 volts; the efficiency decreased from 3.118 watts per candle to 3.468 watts per candle. The resistance of the filament rose from 221.6 to 234.8 ohms. During the first 50 hours the changes were slight; then occurred a sudden increase of resistance accompanied by marked rise in electromotive force and in amount of energy consumed.

The life history of the incandescent lamp at still higher temperature does not differ essentially from that which we have just been considering, but the changes in question go on much more rapidly.

In Figs. 4 and 5 are recorded the performances of two lamps which were similar to those from which the curves in Figs. 2 and 3 had been

obtained. The first of these (see Fig. 4) was started at 57 candles. It was maintained at constant voltage for 11 hours and 30 minutes, when it went out. During its brief life the candle power fell to 24.6, and the watts per candle increased from 1.58 to 3.09. The loss of candle power during the experiment was 55 per cent.—an amount which corresponds very closely with the loss suffered by the first lamp tested during the 800 hours that it lasted. In the case of the other lamp (see Fig. 5) the initial candle power (64 candles) was maintained throughout. Its life under these circumstances was 140 minutes, during which short period it had been found necessary to raise the electromotive force from 114.08 volts to 129.53 volts. The efficiency of the lamp fell, meantime, from an in-

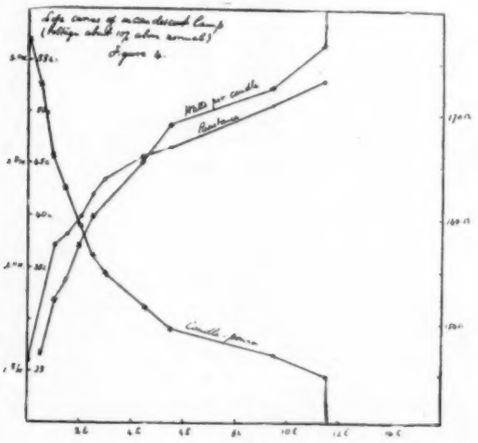

Fig. 4.

itial value of 1.33 watts to 1.677 watts at the end of the first hour; then more and more rapidly to 1.945 watts, at the end of the test.

The conclusion to be reached from these data and from the great mass of experimental results which has accumulated since the incandescent lamp has become an object of investigation, is only too evident. The efficiency of an illuminant in which carbon is the glowing material, is a function of the temperature. It appears that the incandescent lamp is fairly stable only at temperatures for which its efficiency does not exceed about five watts per candle. We have just seen what occurs when

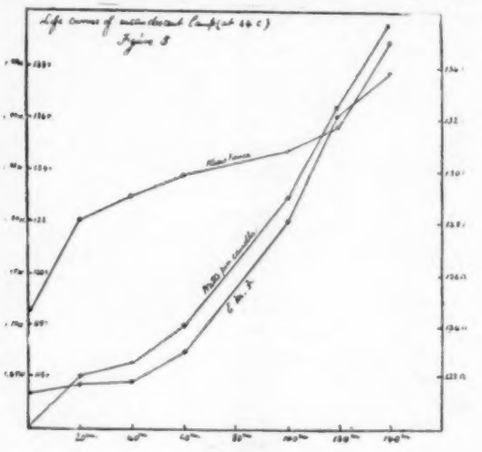

Fig. 5.

one attempts to maintain lamps at degrees of incandescence corresponding to a much higher temperature. It is, perhaps, not possible to point out with perfect definiteness all the causes that are at work to reduce the candle power. The black coating which gradually forms on the interior of the lamp bulb intercepts more and more of the light from the filament as the age of the lamp increases. The growth of this film and its power of absorbing light have recently been carefully studied by two of my advanced students, B. E. Moore and C. J. Ling.

The life curves which I have just shown you were made by them as a necessary part of their investigation of the loss of light due to the opaque film, and I will venture to take from their work, as yet unpublished, the results which they have obtained in the case of the lamp to which the curves in Fig. 2 refer. These results are given graphically in Fig. 6. They show the amount of light of each wave length of the visible spectrum which the coating on the interior of the bulb absorbed. The measurements were made after the lamp had been in operation 100 hours, 200 hours, 400 hours and 800 hours. In the diagram abscissæ are wave lengths and ordinates show the amount of light transmitted by the lamp bulb at the above mentioned times, in terms of the amount which the bulb allowed to pass before the coating began to form. You will see by a glance at these curves that the absorbing power of the film was very nearly uniform throughout the spectrum, so that the blackening of the lamp had no appreciable effect upon the light which it emitted; also that the absorption at the end of 200 hours was considerably more than half as great as that at the end of 800 hours, and that the total loss of candle power due to blackening was about 22 per cent.

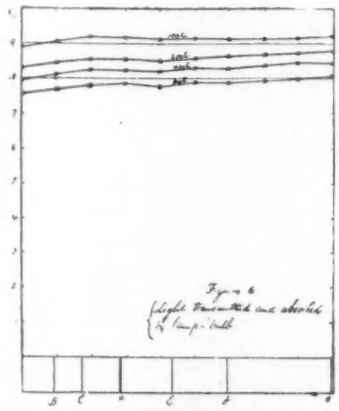

Fig. 6.

These measurements enable us to account for rather more than one-third of the loss of candle power suffered by the lamp. We are not, with our present knowledge, in position to speak so definitely concerning the other two-thirds, but the increase in the resistance in the carbon indicates another source of diminution. That gradual failure of the vacuum which the use of spark coil would unquestionably have enabled the observers to detect, may well be answerable for the rest. Now, the temperature of an incandescent lamp filament at five watts per candle is very nearly the same as that of the carbon in the light-giving flames

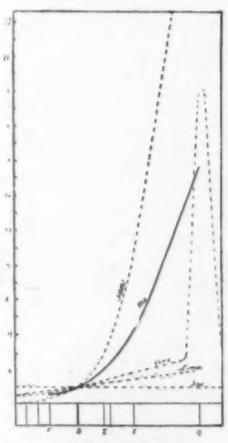

Fig. 7.

produced by the combustion of oils and gas, and it appears that the attempt to pass this temperature introduces difficulties of such a nature as to lead to the serious question whether we have not reached a definite limit beyond which incandescent carbon ceases to be permanent.

At that limit the efficiency of the lamp is very small indeed, 95 per cent. or more of the radiant energy emitted being of wave lengths too long to afford light.

As to the arc light no more encouraging report can be made. On the contrary it is perfectly well established that the quality of the light instead of increasing has fallen off in the course of the development of the lamp from the clockwork regulators of Dubosc and Foucault, with their slender carbons, to the commercial lamps of to-day.

The researches of Nakano,[1] Marks,[2] and others, show that the efficiency of the arc is a definite function of the current density at the terminals of the carbons, increasing nearly in inverse ratio to the cross section of the pencil. When the maximum current capacity of the latter has been reached the efficiency is in the neighborhood of 10 per cent., a value which is not likely to be greatly exceeded by any of the methods in vogue at the present day.

As Edward Weston[3] says in his discussion of Nakano's paper on the efficiency of the arc lamp: "The small amount of luminous energy, compared to the total energy employed, is a sad thing always."

In the vast accumulation of experience which the past years have witnessed, nothing has come to general knowledge which looks to the raising of the barrier which blocks our progress. It seems only too probable that the limiting temperature at which carbon can be used for the production of light has been reached, and with it the maximum efficiency of artificial illumination.

As time goes on, however, the question of the efficiency of illuminants will increase in practical importance. No one of us, I take it, is of the opinion that the world will always be content with the present extravagant methods of obtaining light. Now, if you will permit me, I will turn toward the future and consider the properties of some other sources of light, with the view of inquiring whether they may not have a part to play in the artificial lighting of days to come.

What is to be the light of the future? From the standpoint of the engineer I will frankly say that I cannot answer that question, but abandoning the directly practical point of view, there is something to be said. I need offer no apology here for presenting facts, the application of which is at best remote and the present importance of which is therefore rather scientific than utilitarian.

The number of elements and of compounds capable of sustaining a high temperature without dissociation or change of state is very large. Carbon is the only one of these the capabilities of which as a source of light can be said to have been fully tested; and yet all the others, when heated to a proper point, emit light-giving radiation. Take, for example, the metallic oxides. We heat the oxide of calcium in our magic lanterns and it gives a light of great intensity, and but little inferior to the arc light in whiteness. The exceeding clumsiness of our method of rendering it incandescent, however, has prevented its adoption excepting for certain special purposes. We burn magnesium in fireworks and for photographic flash lights, and occasionally we indulge in the luxury of igniting a bit of the ribbon and admiring, for instance, the intense brilliancy of its flame. Now, magnesium is one of the most abundant elements on the face of our planet. It is a rather costly metal at present, being quoted at 50 cents an ounce in this country, and at about half that price on the continent of Europe. Even under the limited demand for it which exists at present, it has fallen to about one-tenth of its price of a few years ago, and I feel sure that it lies within the power of the electrician to greatly further reduce the cost of production. Among artificial illuminants magnesium has in one respect no equal. W. H. Pickering, who studied its spectrum in 1880, found it to approach sunlight in quality even more closely than the electric arc light does.

The precise character of the magnesium light is shown in Fig. 7. The abscissæ of the curves are wave lengths, and ordinates indicate the brightness of each portion of the spectrum of the magnesium flame in terms of that of the corresponding regions in the spectrum of gas light. The accompanying curves for the arc light and lime light introduced for convenience of comparison, are from measurements by Mr. W. S. Franklin and myself. These curves all refer to lights of the same candle power. It will be seen that the magnesium flame is about ten times brighter in the violet than a gas flame of the same power, and but little more than half as strong in the red. It will be seen, also, that it surpasses the electric arc everywhere beyond the yellow, save in a very limited region of the extreme violet. In order to appreciate fully the significance of these curves one must have had occasion to compare the various lights to which they refer, placing them side by side and noting the effects. You are all aware that the magnesium light is very white and very powerful, but unless you have happened to see it in direct competition with our ordinary illuminants, you will be but dimly conscious of the difference between them.

I have here a single magnesium lamp of European manufacture. By means of a simple arrangement of clockwork it feeds a thin magnesium ribbon at a rate just sufficient to maintain a flame between 40 and 50-candle power. Turn your attention for a moment to the screen just behind us. It gives you the impression of a nearly uniform white surface, which is well lighted by the incandescent lamps with which this hall is so abundantly supplied. Its whiteness, now, however, is a very different thing from that which it will take on under the rays of the magnesium light. I light the little clockwork lamp, placing it so that it illuminates a portion of the screen. That part which is shaded from the lamp is just as well lighted as it was before, and its tint is in no way changed; but no one would be likely to describe it as a white surface under the present circumstances. It has sunken by comparison into a rather weak chocolate brown. Let us turn the lamp so that you can see the burning magnesium, and place beside it, to emphasize the contrast, this lighted candle. How dull and sickly the candle flame appears, and yet, though old-fashioned and rather out of date among our modern glow lamps, the candle does not suffer greatly, so far as quality of light goes, by comparison with them.

This lamp consumes 168 milligrammes of magnesium per minute. I found the light to average slightly more than 40-candle power. Assuming 40 candles to be the correct value, we have 4.2 milligrammes of magnesium consumed per minute per candle. Now, to maintain one-candle power of gas light one minute with an average quality of illuminating gas, 137 milligrammes of gas must be consumed. With gas at $1 per 1,000 cubic feet and magnesium at $10 per kilogramme, a price which is in excess of the present European rate, the magnesium light would cost, candle for candle, about 6.72 times as much as gas. With magnesium at $1.49 per kilogramme, or about 67 cents a pound, the cost of the two illuminants would be the same. Looking at the matter from a slightly different point of view, we may say that since 4.2 milligrammes of magnesium will give as much light as 137 milligrammes of gas, their relative productiveness as illuminants is as 32.1 to 1. The true relation between their values is, however, expressed by a larger ratio than that since candle power for candle power, the real worth of a source of light increases with its temperature. The total luminosity of the arc light, for instance, may be considered fully 25 per cent. greater than that of gas. Two-candle power of sunlight is the equivalent of 3 candles of gas light. The luminosity of the magnesium light lies between these two values.

Taking the very low estimate of 1,000 gramme calories per minute for gas, *we find the gross efficiency of the magnesium flame to be about* 40 *times that of gas light.*

[To be continued.]

1. Hatsune Nakano: Am. Institute of E. Engineers, vol. vi., p. 308.
2. Louis B. Marks: Am. Institute of E. Engineers, vol. vii., p. 175.
3. Edward Weston: Am. Institute of E. Engineers, vol. vi., p. 20.

Gaseous Illuminants.

[An abstract of the first of a series of lectures delivered before the Society of Arts, by Prof. Vivian B. Lewes. Reprinted from the London *Journal*.]

The lecturer began by remarking that, although born scarcely a century ago, gaseous illuminants had made such strides within the last ten years, that no excuse was needed for taking them as his subject; and in doing so, he proposed to treat more especially the new processes which are making their mark in the gas world, and omit those which are either obsolete or gradually being superseded. He then went on to say that just 200 years after Van Helmont (in the seventeenth century) first used the term "gas" to describe æriform bodies, Faraday defined a gas as being the vapor of a volatile liquid, existing at a temperature considerably above the boiling point of the liquid, and that the condensing point of the gas was merely the boiling point of the liquid producing it. This definition was contested at the time, as several of the gases had not then been condensed; but now it was known that the condensation of any gas to the liquid form was merely a question of sufficiently intense cold, and pressure. For instance, at ordinary temperatures, carbon dioxide, or carbonic acid gas, was as good an example of an æriform body as one could adduce, and was recognizable from air only by its physical and chemical properties; but subject it to a temperature of—78.2° C., and it would condense to a clear limpid liquid which might easily be mistaken for water, and which if the temperature were again allowed to rise to 0° C., would require a pressure of 36 atmospheres to to prevent it again assuming gaseous form. If it were released from this pressure, it would at once become gaseous again, and in doing so would absorb so much heat, that a temperature close upon 100° C. was produced, and some of the liquid was frozen into the solid form. This showed that the state of aggregation of the body was dependent on the existing temperature.

Prof. Lewes then proceeded to explain that gases containing hydrogen, compounds of hydrogen with carbon, and compounds of these two with other elements, have most of them so strong an affinity for the oxygen contained in the atmosphere, that the heat emitted by a burning match is generally sufficient to determine combination between the

gases; and where the heat evolved by the combination is sufficient to raise the gases or vapor to incandescence, the phenomenon of flame is the result. Some flames have the power, under certain conditions, of emitting light, while others have no photometric value; and it is a matter of the gravest importance to the gas world that as clear a conception as possible should be obtained of the conditions and cause of luminosity in flames. A visible flame may either be solid—that is to say, composed of a solid mass of incandescent particles—or it may have a distinctive internal structure, and show zones in which varying phases of combustion are taking place; and it is to this latter class that all flames produced by a gas issuing from a burner belong. A moment's consideration will make it manifest that if one gas is issuing in a steady continuous stream into an atmosphere containing the gas with which it is to combine, if combination is set up (in other words, if the gas is lighted) the action can only go on for a limited space from the surface where the two gases meet, and hence such a flame must, of necessity, be hollow, and will contain a central zone in which entire absence of air causes absence of combustion—an intermediate zone in which partial combustion is taking place, only a limited supply of air being able to penetrate. This zone was practically in all cases the light-producing zone; while outside this again it is just possible to discern an envelope of non-luminous flame, where the excess of air destroys all luminosity for reasons which will be discussed later on. The flame is not in contact with the rim of the burner from which the gas is issuing: this space being claimed by some observers as constituting a fourth part.

In the *Philosophical Transactions* for 1817, Sir Humphry Davy first propounded his theory that the cause of luminosity in ordinary flames was the incandescence of nascent carbon—a theory which was accepted as the true one until the researches of Dr. Frankland in 1868, on the effect of pressure on non-luminous flames, showed that, under certain circumstances never likely to arise in a gas flame, luminosity might be due to other causes. Later observers have shown that luminosity in a flame is to a great extent affected by temperature. These factors, though of the greatest importance, do not affect the truth of original theory. In the last contribution to the subject, Davy's theory had, said the lecturer, been attacked by Mr. F. J. Rowan in a paper "On Flame" read before the Glasgow and Scottish Section of the Society of Chemical Industry early in 1889; and inasmuch as his paper had found its way into the hands of everyone interested in gas lighting in the kingdom, he thought it would be of interest to fully discuss a question of such vital importance to the gas industry before passing on to other branches of the subject. This he proceeded to do as follows:

In the introduction to his truly remarkable paper, Sir Humphrey Davy says, while alluding to a paper published in one of the early numbers of the *Journal of Science and Arts:* "I have given an account of some new results on flame which shows that the intensity of the light of flames depends principally upon the production and ignition of solid matter in combustion." It is round this statement that the battle of luminosity has raged; the word "principally," however, being lost sight of, and the theory being more often propounded in the words used by Mr. Rowan, that "the presence of solid particles suspended in the flame (or immediate contact with the burning gas) is essential to its luminosity"—an idea which Davy never had, as is shown by him later in the paper defining flame as follows: "Flame is gaseous matter heated so highly as to be luminous;" and again: "When in flames, pure gaseous matter is burnt, the light is extremely feeble." Moreover, he alludes to "common flames"—evidently meaning the flames of candle, lamps, or gas; in all which cases I think it can be proved beyond a doubt that his theory, as expounded by himself, was perfectly correct. On June 11, 1868, Prof. E. Frankland read a communication before the Royal Society, in which he described experiments which led him to doubt Sir Humphry Davy's theory. He points out that the deposit of soot formed when a cold surface is held in a gas or candle flame is not pure carbon, but contains hydrogen, which can only be got rid of by prolonged heating in an atmosphere of chlorine. Also that many flames possessing a high degree of luminosity cannot possibly contain solid particles. Arsenic burnt in oxygen gives a bright white light; yet as arsenic volatilizes at 180° C., and the arsenic trioxide forms at 218° C., it is evident that at the temperature of incandescence (which is at least 300° C.) there can be no solids, but simply vapors present in the flame; and for the same reason, the intense light resulting from the burning of phosphorus in oxygen cannot be explained by the solid particle theory. From these results, Dr. Frankland considers that "incandescent particles of carbon are not the source of light in gas and candle flames, but that the luminosity of these flames is due to radiations from dense but transparent hydrocarbon vapors;" and he further shows that non-luminous flames, such as that produced by carbon monoxide and hydrogen, can, when burning in an atmosphere of oxygen, be rendered luminous if the ordinary atmospheric pressure is increased to 10 atmospheres, so as to prevent or retard as far as possible expansion during combustion. From Dr. Frankland's experiments, there is no doubt that the luminosity of a flame is increased by pressing around it the atmosphere in which it is burning, and also that rarefaction has the opposite effect—a point also worked at by Davy; but his experiments do not show that incandescent particles of carbon are not the principal source of luminosity in a gas flame. He also shows that the higher the density of the vapors present in a flame, the more likely is it to be luminous.

In 1874, Soret attempted to demonstrate the existence of solid particles in a luminous hydrocarbon flame, by focussing the sun's rays on the flame, and examining the reflected light by means of a Nicol prism; but neither his research nor that of Burch, who repeated his experiments, using the spectroscope instead of the prism, showed more than that solid particles are present. Herr W. Stein, in considering Dr. Frankland's objections to Davy's theory, pointed out that the soot which is deposited from a candle or gas flame, and which Frankland looked upon as a condensed hydrocarbon, contains 99.1 per cent. of carbon and only 0.9 per cent of hydrogen, which is about the quantity of hydrogen one would expect to be occluded by carbon formed under these conditions, and he also pointed out that if the soot were a heavy hydrocarbon condensed by a cold surface, cooling the vapor present in the flame, it ought to again become volatile at a high temperature, which it does not. The next steps in the controversy were the attempts made by Hilgard, Landolt, and Blochman, to trace the actions taking place in various flames by withdrawing the gases from different parts of the flame and determining their composition. Ordinary 16 to 17-candle coal gas as supplied in London may roughly be taken as consisting of:

	Per Cent.
Hydrogen	51.6
Marsh gas, or methane	36.7
Illuminants	5.8
Carbon monoxide	5.1
Carbon dioxide	0.0
Nitrogen	0.6
Oxygen	0.2
	100.0

Of these the three last only exist as traces, and do not play any part in the combustion. Of the remainder, it is found that the hydrogen burns most rapidly; then the carbon monoxide; next the marsh gas; while the illuminants are the slowest to burn. When, however, at the bottom of the flame, hydrogen and carbon monoxide enter into a non-luminous combustion, forming water vapor and carbon dioxide with the oxygen of the air, they have by no means completed their function, as the aqueous vapor, passing upwards through a zone of intense heat, becomes again dissociated to a certain extent into hydrogen and oxygen; while the carbon dioxide, coming into contact with incandescent carbon, liberated from the heavy hydrocarbons forming the illuminants, is one more reduced to carbon monoxide—these only finally completely recombining to saturated products of combustion in the outer non-luminous zone of the flame. Landolt took an ordinary rich coal gas flame 3½ inches in height, and traced the changes taking place by withdrawing the gases in the flame at various points from the orifice of the burner up to 2 inches above it, with the following results:

Composition of Gas in Flame.	Height from Burner in Inches.					
	0	0.39	0.79	1.18	1.58	1.97
Hydrogen	22.66	14.95	15.49	15.54	14.50	11.95
Marsh gas	33.77	30.20	28.34	21.55	11.92	3.64
Carbon monoxide	7.34	14.07	14.05	14.58	22.24	25.14
Olefines	7.29	7.49	7.87	7.94	7.05	5.45
Oxygen	0.66	0.78	0.47	....	....	....
Nitrogen	29.41	38.66	140.78	184.23	270.45	307.10
Carbon dioxide	1.94	2 34	10.11	14.98	23.76	32.34
Water	8.34	11.60	38.85	52.55	72.67	75.61

He used a gas containing a high percentage of illuminants, and on examining his results we see that the hydrogen is the first to burn, as one would expect from its relatively low igniting point and great rapidity of combustion. The burning of the carbon monoxide cannot be traced in the same way, as it is formed more rapidly (by the incomplete combustion of the marsh gas) than it burns, so that a steady increase in the proportion present takes place while the marsh gas steadily burns away, until a height of 1½ inches is attained, when its combustion becomes very rapid. Practically, the illuminants do not undergo any change at first—indeed, they slightly increase in quantity from the decomposition by heat of some of the marsh gas into acetylene. They only begin to decompose at a height of 1½ inches above the orifice of the burner, and

then burn rapidly in the highest part of the flame. Moreover, a most important fact to be noted is that at the height of 1½ inches there is a sudden rise in the quantity of carbon monoxide at the moment that the illuminating olefines begin to disappear—a result undoubtedly due to the action of the nascent ignited carbon or carbon dioxide. Among the illuminants are several hydrocarbons, the probable composition of which will be discussed in the next lecture. These are gradually broken down into intermediate stages in the lower part of the flame, until finally tney become marsh gas and carbon ; and it is the carbon in excessively minute particles which at the moment of liberation is heated to incandescence, and "principally" gives the light of the flame—the marsh gas originally present, and also that formed from the heavier hydrocarbons, adding its quota to the luminosity by still further decomposition during combustion, and finally becoming carbon dioxide and water. In 1876, Dr. Karl Heumann made a most important contribution to the theory of luminous flames in some papers published in Liebig's *Annalen*, in which he carefully went over the work of previous observers, and, by a large number of original experiments, proved that Davy's theory was correct, but that other causes also affected the degree of luminosity in a gas or candle flame.

In the ordinary atmospheric burner in which a mixture of coal gas and air burn with a non-luminous flame, it was supposed that the admixture of air, by supplying oxygen to the inner portion of the flame, caused immediate and complete oxidation of the hydrocarbons, without giving time for the liberation of carbon in the flame, and consequently luminosity. More modern researches, however, have proved this to be utterly wrong. The loss of luminosity is due to two causes—first, to the diluting action of the air introduced ; secondly, to the fact that when a gas is so diluted it requires a far higher temperature to break up the hydrocarbons present than when the gas is undiluted, and therefore the temperature which serves to liberate carbon and render the undiluted gas flame luminous, is totally insufficient to do so in the diluted gas. Consequently the hydrocarbon burns to carbon dioxide and water without any such liberation, and hence with a non-luminous flame. The truth of this theory can be easily proved by the fact that diluting the gas with nitrogen, carbon dioxide, or even steam, serves to render it non-luminous, and therefore more rapid oxidation has very little or nothing to do with it, while the non-luminous flame can again be rendered luminous either by heating the mixture of air and gas just before combustion, or by heating the air with which the gas is diluted. This being so, it is evident that in the non-luminous flame we have the same hydrocarbon present as in the luminous flame; and anything that will tend to break them up and liberate the carbon before the hydrocarbons are consumed, should again make the flame luminous. That heat will do this has been already shown : but it can be demonstrated in a still more striking way. It is well known that chlorine gas and bromine vapor will both support the combustion of a gas containing much hydrogen, but that the combustion is very different from that of the same gas burning in air, as the chlorine or bromine, having no affinity for the carbon, combines with the hydrogen only, and deposits the carbon in clouds of soot ; in other words, at the temperature of flame, chlorine will break up the hydrocarbons and liberate solid carbon. If now a small quantity of chlorine is led into the non-luminous Bunsen flame, it at once becomes luminous ; proving conclusively that luminosity is due to solid particles of carbon liberated in the flame. Again, Heumann points out that a small rod held in the luminous flame becomes rapidly covered on its lower side with a deposit of soot; that is to say, the soot is present in particles in the flame, and the uprush of the gas drives it against the rod and deposits it there. If the soot were present in the flame, as Frankland supposed, in the state of vapor, and the rod merely acted by cooling and condensing it, the soot should be deposited on all sides of the rod; while a still further proof is that if the soot existed as vapor in the flame, then if the rod were heated to a high temperature no soot should be deposited on it, whereas the soot deposits on a heated surface just as well as on a cool one.

It has been objected to the "solid particle" theory that, if it were true, solid carbon particles introduced into a non-luminous flame should render it luminous and make it look like an ordinary gas flame, whereas it simply gives rise to a cloud of sparks. But it must be remembered that the "nascent" carbon, as it is liberated from the decomposing hydrocarbons, is in the molecular condition, and has a very different degree of coarse-grainedness to any preparation of charcoal or lampblack we can make ; and that, although our finest particle is a mass which takes so long to burn that it leaves the flames only partly consumed, and is projected into the air as a spark, the molecular particles of carbon are consumed as soon as they are rendered incandescent, and a steady luminosity, free from sparks, results. It is possible, however, to make the particles in a luminous flame roll themselves together, when they can be either deposited in a very coarse kind of soot, or be seen as glowing sparks and particles in the mantle of the flame. This can be done when two luminous flames are allowed to rush against each other or against a heated surface. Heumann also shows that the luminous mantle of a flame is not altogether transparent, and that the thicker the flame layer, and the greater the number of solid particles contained in it, the less transparent does it become If a non-luminous flame—say, hydrogen—is charged with the vapor of chromyl dichloride (CrO_2Cl_2), chromic oxide is produced; and this flame, which undoubtedly contains solid particles, is quite as transparent as the hydrocarbon flame. Finally, those flames which undoubtedly owe their luminosity to the presence of finely divided solid matter produce characteristic shadows when viewed in sunlight ; the only luminous flames which do not throw shadows being those which consist of glowing vapors and gases. Luminous gas flames, oil lamp flames, and candle flames, produce strongly marked shadows in sunlight, and therefore contain finely divided solid matter ; and that this can be nothing but carbon is evident from the fact that all other substances capable of remaining solid at the temperature of the flames are absent.

From the foregoing considerations, it seemed to the lecturer that Sir Humphrey Davy's statement that the intensity of the light of flames (such as those produced by candles, oil or gas) depends principally upon the production and ignition of solid matter in combustion, was undoubtedly the true one ; and it must also be borne in mind that the degree of luminosity of a flame is affected by the constituents of the gas other than the heavy hydrocarbons—some, like marsh gas, although ordinarily burning with an apparently non-luminous flame, and separating no soot, adding considerably to the luminosity at the temperature of the flame, while others, like carbon monoxide, reduce it. This question, which he hoped to discuss in the next lecture, has, he said, most important bearings upon the illuminating values of the newer forms of gaseous illuminants. Finally, in considering the amount of light obtainable from a flame, the question of temperature, which would be brought forward when he came to speak of the newer forms of gas burners, must not be lost sight of. The luminosity of a flame is increased by an increase of density in the media in which it is burning, and is decreased by rarefaction—an effect supposed by Dr. Frankland to be owing to the alteration of density and alteration of the mobility of the oxygen molecules in the air. This view, however, had been contested by Wartha, who concluded that it was due to the effect of pressure on the dissociation point of the hydrocarbons burning in the flame ; this taking place more rapidly under increased pressure, and therefore liberating the carbon more quickly. However this might be, the effect of pressure on luminous flames was very marked, even under ordinary atmospheric pressure ; the difference of an inch in the barometric column making 5 per cent. difference in the luminosity. A burner giving 100 units of light with the barometer at 30 inches would only give 95 units if it fell to 29, while a rise to 31 inches would mean an increase of the luminosity to 105 units.

The lecture, which was accompanied by a number of beautiful experiments, was attentively followed by a large and appreciative audience.

Coke Making in Early Days.

According to the compiler of a pamphlet which bears the title "Connellsville Coke," the infancy of the coke industry may thus be traced :

It is claimed that coke was used in this country in the manufacture of pig iron a few years before the Revolution. While this is possible, it is not probable that coke was used here at so early a date.

It was not until 1735 that coke was successfully used in England, and it did not come into anything like general use in that country as a blast furnace fuel until 1750. After the Revolution numbers of skilled iron workers found their way to this country, notwithstanding the stringent laws against emigration and the heavy penalties imposed upon those attempting to emigrate ; and among these workers were doubtless a few skilled in the manufacture and use of coke. The Pittsburgh *Mercury*, May 27, 1813, contained the following advertisement :

"To proprietors of blast furnaces :—John Beal, lately from England, being informed that all blast furnaces are in the habit of melting iron ore with charcoal, and knowing the great advantage it is to proprietors, is induced to offer his services to instruct them in the method of converting stone coal into coak. The advantage of using coak will be so great that it cannot fail becoming general if put in practice. He flatters himself that he has had all the experience that is necessary in the above branch to give satisfaction to those who feel inclined to alter their mode of melting ore. JOHN BEAL, Iron Founder."

In 1816 and 1817 Col. Isaac Meason built the first rolling mill erected west of the Allegheny mountains to puddle iron, at Plumstock, Fayette county, Pa. This mill went into operation September, 1817, and coke was used in the refinery. This is the first definite statement that can be found concerning the use of coke in this country. It is interesting to note that coke used at this mill was made on Redstone creek, in Fayette county, which to-day is the greatest coke producing county in the United States. The next notice we have of the use of coke was at a blast furnace on Bear Creek, Armstrong county, Pa. This furnace was built to use coke, and went into operation in 1819. It was, however, unsuccessful, the blast being weak, and the furnace chilled after making two or three tons of iron.

In 1835 the Acting Committee of the Pennsylvania Society for the Promotion of Internal Improvement sent an agent to England to study various subjects relating thereto, and specially charged him to investigate the method employed in the manufacture of iron. In 1835 the Franklin Institute of Pennsylvania offered a premium of a gold medal "to the person who shall manufacture in the United States the greatest quantity of iron from the ore during the year, using no other fuel than bituminous coal or coke; the quantity to be not less than 20 tons." In the same year this offer was made William Firmstone was successful in making good gray forge iron for about one month at Mary Ann Furnace, in Huntingdon county, with coke. Firmstone is doubtless entitled to the honor of having been the first successful manufacturer of coke pig iron in this country, just about 100 years after the successful use of coke in England.

In 1837 F. H. Oliphant made coke iron at his Fairchance Furnace, near Uniontown, and in a letter to the Franklin Institute, dated October 3, 1837, he claimed the premium offered by them. From 1836 to 1839 other attempts were made to use coke in Pennsylvania furnaces without success. On June 16, 1836, the Legislature of Pennsylvania passed an act to encourage the manufacture of iron with "coke and mineral coal" which gave the Governor authority to charter companies with ample power to prosecute this branch of industry. In 1849 there was not a coke furnace in blast in Pennsylvania. In 1856 there were 21 furnaces in Pennsylvania and 3 in Maryland using coke, but none of them using Connellsville coke, and it was not until the development of the Connellsville region that the use of coke as a blast furnace fuel came into favor or the manufacture of coke itself in this country assumed any importance.

As early as 1817, as has been stated, coke was used at Plumstock. It is also said that some attempts were made in 1819 to use coke in blast furnaces in the neighborhood. All this early coke was made on the ground; the first coke made in ovens was about 1841. It was in this year, 1841, that Provance McCormick and James Campbell, two carpenters, overheard an Englishman, as the story goes, commenting on the rich deposits of coal in Connellsville and its fitness for making coke, as well as the value of coke for foundry purposes, and they determined to enter into the business of manufacturing coke. Associating with them John Taylor, a stonemason and the owner of a farm on the Youghiogheny River, including a coal mine, which he operated in a small way, they commenced operations. Taylor constructed two ovens, and in the spring of 1842 enough coke had been made to fill two boats 90 feet long, or about 800 bushels. They started down the river on a high stage of water to Cincinnati. On reaching that city they found that the demand for coke was not as brisk as they had hoped to find it. The new fuel was unknown there, and foundrymen regarded it with suspicion, calling it "cinders." Campbell, who went with the boats, remained at the landing three weeks, retailing out one boat load in small lots at 8 cents a bushel. He traded the balance to Miles Greenwood, a foundryman, at Cincinnati, for a patent iron grist mill. The mill was brought to Connellsville, and when put in operation was found to be a failure, and it was sold for $30, and so ended the first coke manufacturing firm in the Connellsville coke region.

A part of their cargo which had been traded for the patent mill, was afterwards boated by canal to Dayton, O., and there sold to Judge Gebhart, a former resident of Fayette county, who then had a foundry in operation in Dayton. He used the coke in his establishment, and found it so well adapted for his purpose that he soon after came to Connellsville and proposed to Campbell and McCormick to make more, but the result of their previous venture in the coke trade satisfied them. In 1843 the ovens built by Taylor were rented to Mordecai, James and Samuel Cochran, who used them in making 24-hour coke. When they had coked about 1,300 bushels it was boated to Cincinnati and sold to Miles Greenwood, who in the meantime had become acquainted with the value of coke as a fuel. This is said to have been the first coke ever taken from Fayette county and sold for money, and was the beginning of the coke business in the Connellsville region, and the Cochrans must be considered the pioneers in the coke business in that region. James Cochran, one of the three named above, or as he is familiarly known, "Little Jim," is still in the business. He has his sons associated with him, and is operating under the firm name of James Cochran, Sons & Company.

About 1850 three or four ovens were built and put in operation by Stewart Strickler, the product being sold by him to the Cochrans, who boated it to Cincinnati and sold it. For some years but little coke was made, though a few ovens were built and that knowledge acquired which was necessary for the coming development of the trade. The trade increased somewhat in 1851, and in 1855, it is stated, there were but 26 coke ovens above Pittsburgh. It was not until the Pittsburgh and Connellsville Railroad was completed to Connellsville, and Connellsville coke had been successfully used in the Clinton Furnace, Pittsburgh, that its value as a furnace fuel was fully demonstrated and the foundation laid for the demand that has resulted in such an unprecedented development of coke manufacture in the Connellsville region.

Selections of Building Materials.

The most important matter, in preparing plans for a new structure, says the *Carpenter and Joiner*, to decide upon is the selection of the material. This, to a large extent, is determined by its cost, but not to so great an extent as might be imagined. It is to be taken for granted that an architect will build his structure of the best material his cost limit will permit. Now, this does not mean always the costliest material, although the public are apt to think so; but if the designer be a man of fine taste and well trained in his art, he will select a material that, while essentially durable, will confessedly subserve the best effect. Effect is a prime cause with every architect who has a genuine love for his art, and to a large extent is the dominant feeling in the design, but he still has a wholesome respect for a material that is admitted substantial and durable.

If the new structure is a public building, he will naturally choose stone in preference to brick for his external walls, because with stone he can obtain a more noble and dignified effect. With stone, too, he can obtain a much more beautiful and permanent color scheme, and if the structure will admit of decoration, he can obtain, more closely, a better interpretation of his designs than is now possible in brick or terra cotta. Public buildings demand dignity and repose and simplicity of coloring, and stone, as a material, offers the proper medium of expression. As to stone itself, great care and considerable knowledge of its structure is required to enable an architect to make a proper selection.

Considerations governing the choice of material exist naturally in the purpose of the proposed structure, its geographical location and its situation with respect to adjoining or contiguous structures. In addition to these, a further condition is imposed on its selection by a circumstance which we have reason to believe is seldom thought of, namely, the character of the coal burned in its immediate vicinity. In a district where soft coal is used largely for manufacturing purposes it is impossible to use a coarse, white stone, such as granite, marble or limestone, because soot becomes deposited on its roughened faces, and darkens and ultimately blackens the entire stonework to such an extent as to destroy its original expression. Where the use of soft coal prevails so as to become detrimental to the beauty of stonework, it is necessary to resort to brick and terra cotta work, because they are not injured so readily as stonework. Where granite is to be used it is advisable to employ it in such a manner that it will not be damaged by fire from other buildings. This can be done only by strict isolation, and would relegate granite to isolated public buildings. For office buildings, built close to adjoining tructuress, it is evidently quite unsuitable. Granite-faced structures are often built of one uniform tone as to color, and the effect is cold and harsh. This practice has prevailed in the past, but it is gratifying at the present time to observe a marked change in this regard. Dark colored granites are now used for lower stories upon which are imposed stories lighter in color as the crowning cornice is approached. This choice is in keeping both with the proper expression of stability and of aerial perspective.

Where brick is chosen for the sake of its inviting field as to color, it is necessary to use the utmost care in selecting not only materials but color. Brickmakers, with good judgment and taste, owing we believe, to the urgent demands of architects and their clients, have been making marked innovations not only in the color of brick, but in their forms. Bricks 12 inches long, 1½ inch to 1¾ inch face, are now made. Other irregular sizes are obtainable, and in addition to this, rock-faced stonework has been imitated by rough-faced brick. This roughing face is a moulded face, and when used in a climate or locality free from soft coal

smoke, it can be used to great advantage It is a mistake, however, to suppose that artistic brickwork is cheaper than desirable stonework. The choice of either at the same cost is dependent, to a large extent, on the capability of the designer. Some men have a positive talent in designing brickwork which will be exquisite in its refinement of line and its delicate glow of color. In every case permanent effect is the ultimate aim, and can be obtained only by an almost encyclopedic array of information which has been carefully classified and fully studied.

The Chemistry of Illuminating Gas.—Condensation.

A most interesting chapter in the series of articles, on the chemistry of illuminating gas, that have been published in the London *Journal*, under the signature of our special English correspondent, Mr. Norton H. Humphrys, is that on condensation. Mr. Humphrys writes:

Under the head of "Condensation" may appropriately be included the treatment to which gas is subjected from the time it leaves the retort until it is delivered at the inlet to the washers or scrubbers. The advancement in respect to this department has been greatly hindered by several circumstances. First, we find that although the behavior of the gas under various conditions during the act of cooling or of separating tarry matters has repeatedly been the subject of elaborate investigations these have always commenced at the outlet of the hydraulic main; that is to say, after one-third or one-half of the total condensable matter has been separated, and the temperature reduced more than one-half. If so much care should be taken in finishing off in the precipitation of the last half of the tar, and in effecting the last 100° of reduction in temperature, one cannot but wonder whether it would not be more advantageous to start at the beginning, and extend the same care with regard to gradual cooling, etc., right back to the very mouth of retort. It is probable that the gas suffers a greater degree of reduction in temperature during the time it is traveling up the ascension pipes than it does while passing through the whole of the plant included under the term "condensing apparatus," as popularly used. And if a sudden reduction of temperature to the extent of 20° or thereabouts is prejudicial to the quality of the gas, what must be the result of the progress through the ascension pipes and hydraulics, which may really be described as a sort of "slow speed" condenser and a hot washer. Then there is always a tendency to mix up the work of purification with that of condensation. It is generally the custom to claim for any new invention that it is to separate the tar, prevent naphthaline deposits, improve the quality of the gas, and generally give the advantages that are to be expected from a better system of condensation; also that it gives a certain quantity of ammoniacal liquor. Or possibly analyses showing the percentages of the various impurities removed from the gas are quoted. Most of us are acquainted with the street performer who ingeniously manages to play a number of musical instruments at one time; but it is questionable whether he produces as good music as would result from the distribution, amongst an appropriate number of competent performers, of the various instruments crowded upon him. In a similar manner it may be questioned whether an apparatus that cools the gas and secures the precipitation of the tar, can also at the same time effectually wash the gas with water. A certain amount of ammoniacal liquor must of necessity be precipitated with the tar; but there are several reasons why it would be better to reserve the watery fluid for use in a subsequent process, than to attempt an intimate contact with the gas at this stage.

A third cause which has hindered advancements in the matter of condensation, particularly of late years, is the general air of vagueness and uncertainty that has grown up around the question. A large number of investigators have pursued the subject with a directness of purpose that leaves nothing to be desired. The Rev. W. R. Bowditch, Mr. Wm. Young, Mr. Henry Aitkin, Mr. R. H. Patterson, Mr. G. Livesey, MM. Cadel, Chevalet, Bremond, and others, might be named as examples of those who have laid down useful guiding lines. Yet, with all this matter available, I have seen some examples of modern ideas on the subject of condensation that are little better than a jumble of the phrases "light tar," "heavy tar," "light hydrocarbons," "heavy hydrocarbons," "hot condensation," "removing products at high temperatures," "importance of adjustment of temperatures," etc. The terms "hot" and "high temperature," for instance, are used by some speakers as representing 300° or 400° F.; while others evidently mean anything considerably above atmospheric temperature—say, 100° or thereabouts.

Another consideration is the fact that there is no point upon which gas engineers are more conservative than that of condensation. After a winter's experience with the vagaries of naphthaline, for example, they are only too thankful if they can hit upon a plan that will insure immunity from this pest, and give fairly satisfactory results. Once so fortunate as to secure this *desideratum*, a great temptation must be offered to induce the engineer to try new condensation schemes. It must also be confessed that many so-called improvements have turned out to be rather erratic and unmanageable in practical operation, if, indeed, they should not be classed as failures.

The number of appliances in connection with condensation that have secured anything like general favor is very small. On the other hand, the number that have been introduced, and perhaps tried at three or four different works—producing results to which public attention is directed—which have not only failed to find further favor, but have gradually sunk into oblivion, is large. Perhaps this is the reason why, in spite of all that has been written and said about the importance of systematic condensation, and the defects of the existing arrangements, the latter still continue in use as regards at least 90 per cent. of the gas that is made. In England, at any rate, the general rule is this: First the ascension-pipe; then the time-honored, much abused, but withal trustworthy hydraulic main; next the long and large foul main; and lastly a set of annular or pipe condensers. It is also remarkable that the practice in condensation appears to follow national lines. England, for instance, may be called the home of the foul main; frictional condensation is generally used in France; while our American brethren like to have something in the way of hot condensation.

The object of condensation is to remove all matters amenable to mechanical treatment, that are likely to give trouble further on, either in the purifying, the storing, or the distributing apparatus. The importance of thoroughly removing everything that is likely to appear as a tarry or an oily deposit during the application of solid or liquid reagents to the gas, cannot be too strongly insisted upon. Such deposits have the effect of clogging the purifying material, and interfering with that intimate contact which is so essential to economical and efficient purification. The presence of deposits in the holders, mains, services, or meters is also objectionable, not merely from the liability to cause stoppage of the supply, but because they absorb valuable light-giving constituents from the gas. So far there can be no disagreement. On the question of the proper temperature at which the gas should leave the condensers, however, there is some difference of opinion. While many prefer to reduce it to that of the atmosphere at this point, others talk about the evil effects of "over" condensation, and assert that the gas should not be reduced below a certain temperature—say 60° F.—at the outlet. So long as the operations of washing, purifying, and storing are conducted in vessels freely exposed to outdoor temperatures, it seems absurd to talk about allowing the gas to leave the condenser at or about a fixed temperature. What is the use, for instance, of taking care not to reduce the gas below 60° in the condenser, but letting it go at that temperature into the scrubber, where it meets with a sudden douche of water at, say, 40°, and afterwards into a purifier and holder at 38° or less? Any advantage secured by careful adjustment at the outlet of the condenser will be lost unless the gas can be protected right through to the burner of the consumer from further loss of temperature. Granting that such reduction to atmospheric temperature may lead to a further separation of hydrocarbons, and to some loss of illuminating power, it is of no use to put a high quality gas into the holders, if such quality cannot be maintained right away to the premises of the consumer; and if immunity from further deposits is to be secured, the gas must obviously be reduced, in the condensing apparatus, to the lowest temperature it is likely to reach in the course of its existence.

Assuming this to be allowed, we now come to the question: What is the advantage gained by systematic condensation, as compared with the usual plan of providing apparatus of ample capacity, and then leaving matters to take care of themselves? By the term "systematic" condensation, I understand the adjustment of the extent of apparatus in use, according to the quantity of gas being made, or to climatic variations. Apparatus capable of dealing with the maximum make is provided and divided into two or more sections, so that either one or any number up to the full capacity can be worked, as may be desired. While there is no necessity for maintaining the whole in operation at a time when half is more than sufficient, there will not be any prejudicial effects on the gas by doing so, if all is as it should be. If the inner surfaces of the condensing apparatus are coated with tar, it is possible that the quality of the gas may suffer by contact therewith. But if everything is properly designed at the inlet end of the apparatus, there will be no tar that is worth the name at or near the outlet end. There may be a little light and thin oily matter; but nothing of a nature likely to injure the gas.

The application of the plan of systematic condensation in such a way that, day and night, summer and winter, the gas should be delivered at the outlet at an even temperature, not varying, let us say, between 55° and

60° F.—or, to put it another way, that the gas should leave the condenser just so soon as it had parted with its condensable matter, not before and not after—would call for a great deal of care and continual attention. On account of circumstances that need not be noticed here, the make of gas is varying from hour to hour; and not only this, but the atmospheric conditions vary also. Apart from the effect of sudden sunshine, storms, cold wind, snow, etc., all of which can, and undoubtedly should, be guarded against, the temperature of the atmosphere will vary through a range of 20° in as many hours. So that it would either be necessary to house the apparatus, and adopt special precautions for maintaining the temperature at the desired degree, or else to tell off an attendant for the special duty of watching the thermometers, and adjusting the condensing arrangements accordingly.

Since it appears then that any refined process of condensation would mean trouble and expense, with but little tangible advantage, the best plan is to go no farther in this direction than to place the condensing apparatus under cover in a sheltered locality, and possibly to divide it into two or three sections, which can be used according to the make of gas. The condensing apparatus, as a whole, will be so designed as to be capable of dealing with the maximum requirement; and it is well to provide each section with a separate overflow-pipe, so that the quantity of fluid deposited therein can be easily estimated. A cased thermometer of the usual construction will, of course, be used in each instance; and by carefully watching the quantity of fluid deposited, and the reduction of temperature, it is easy to form an intelligent idea of the action going on. It is not a difficult matter to arrange the overflow so as to admit of the introduction of a measuring vessel, whereby accurate estimates can be made of the quantity of liquor deposited, and samples of the liquid obtained for examination.

The numerous forms of apparatus used for condensation may be resolved into two classes—chamber condensers and friction condensers; and many of those in common use combine the characteristics of both. In the chamber condenser, the gas moves so slowly that opportunity is afforded for even the finest suspended matters to settle out of it; and in the friction condenser the same result is obtained by causing the gas to impinge upon surfaces suitably arranged. A pipe condenser may partake more especially of one or other of these principles, according to its proportions. If sufficiently large in sectional area to allow a rate of travel for the gas of not more than a few inches per second, it is a chamber condenser. But if the gas moves through it at a comparatively rapid rate, then it depends more for its efficiency on the contact of the gas to the sides of the pipe, the impact afforded by bends and curves, etc.; and it is practically a friction condenser.

The annular condenser, which is by far the most popular form of apparatus, probably depends for its efficiency not so much on the large extent of surface to which the gas is exposed as on the effect of impact afforded to the gas at the inlet of each column. The gas entering at the inlet-pipe strikes directly on the surface of the inside cylinder, which is opposed to it, and then diffuses itself into the annular space. When the annular condenser is fixed close on the outlet from the hydraulic main, this action is apt to manifest itself in a very disagreeable way, by frequent stoppages at the base of the first column. But, as a general rule, the "annular" is used as the finishing apparatus. The difficulty experienced with any arrangement of the friction kind is that, after a time, the surfaces become coated with a very viscid, gummy sort of pitch, which greatly interferes with the efficiency of the condenser, besides tending to impoverish the gas. This difficulty is the more marked the nearer the apparatus is fixed to the hydraulic; so that possibly the general modern practice of commencing with a foul main having dimensions sufficiently large to enable it to act chiefly as a chamber condenser, and finishing with an annular condenser, is really sound in principle.

Efficiency of a Combined Engine and Dynamo.

The direct union of engine and dynamo on a single base is rather growing in frequency. The exigencies of ship lighting have created a demand for such machines, and as the average speed of dynamos has greatly fallen, owing to improved construction, the direct coupled machine is coming into more and more prominence. Some interesting tests have recently been made in England with a direct coupled machine of the Edison-Hopkinson type, driven by a compound double crank engine made by Willan & Robinson. The results of the test show an efficiency of engine and dynamo that is emphatically remarkable, and distinctly greater than any similar result which has heretofore been reported.

The particulars of the engine and dynamo are as follows: The engine is a double cylinder compound, with low pressure cylinder 14 inches in diameter and 16 inches stroke, working with 120 pounds of steam pressure. It is coupled to a dynamo constructed for an output of 475 amperes at 110 volts when driven at 430 revolutions per minute. The armature is of the bar construction, is plain shunt wound, and is fitted with a commutator of hard drawn copper with mica insulation. Four brushes are carried on each rocker arm. Some details of the machine and its performances are as follows:

Resistance of magnets	16.	ohms.
Resistance of armature	0.0055	"
I. H. P.	83.3	
E. H. P.	72.2	
Total efficiency	86.7	per cent.
Consumption of water per I. H. P. hour.	21.6	pounds.
Consumption of water per E. H. P. hour	25	"

As may be readily seen from these figures, the engine and dynamo were worked above their full normal output, which fact would tend to slightly increase the efficiency.

Another test made with a precisely similar combination, working at its normal load, gave the following results:

Resistance of armature	0.0058	ohms.
Resistance of magnets	15.6	"
I. H. P.	85.3	
E. H. P.	70	
Giving a total efficiency of	83.3	per cent.

In the first experiment the electrical losses were as follows: Loss in magnet coils, 756 watts, equal to 1.4 per cent.; loss in armature coil, 1,386 watts, equal to 2.6 per cent., so that the electrical efficiency of the machine due to ohmic resistance alone was 96 per cent. The remainder of the losses, a little over 8 horse power, is due to friction of engine and dynamo, hysteresis and the like. This is certainly an admirable showing, both for the engine and dynamo, for not only must the latter be more than usually efficient, but the former must be singularly light running to give so small an amount of friction. Mather & Platt, builders of the dynamo, have constructed a large number of similar combinations. Those refered to are part of a considerable order made for ordinary electric light service.

A Few Hints on Cement.

A correspondent of the *Engineering Record*, in writing to that paper on the qualities of cements, says:

Cement, with its many admixtures of sand and other "aggregates," is one of the most important materials entering into the construction of nearly all departments of engineering.

The rigid enforcement of mechanical tests, and in some foreign countries a chemical test, which, in the writer's opinion, should be the rule and not the exception, has brought the cement industry to a high standard.

It is desirable that some uniform method of testing cement be adopted whereby the interest of the manufacturer should receive as much protection as that of the consumer.

Probably more injustice is done to the manufacturer by the use of fine sand of a quicksand nature, or sand of a loamy nature, or loam mixed with gravel or broken stone, than in any other way, and it is here suggested that a standard sand be specified in specifications, and a method both mechanical and chemical employed to test its quality.

A good cement is sometimes temporarily condemned when investigation proves the cement to be up to standard while the sand is anything but desirable. A simple test for sand, which can be performed on the work without waiting for the mechanical test, is to place a tablespoonful of the sample to be tested in a small wine glass or test tube, and add to this 3 or 4 tablespoonfuls of a solution of hydrochloric acid, the acid solution being 4 parts water to 1 of acid. If no reaction, effervescence, etc., occurs, the sand may be used, but should there be a perceptible effervescence, it should be regarded with suspicion.

This is a point which, in the writer's experience and observations, has not received the attention upon actual construction which it should.

A few experiments with glass lamp chimneys will satisfy the engineer that cement expands in setting under water, while in air it contracts.

In this connection the writer would say that he has never been successful in making a perfect bond between brick masonry and cement concrete when water-tight work was required. For instance, sewers are sometimes built with a brick invert several rings in thickness, and the arch turned with but one ring of brick, upon which is placed cement concrete, the bond between this 4-inch ring and cement concrete does not remain perfect. This may be due to unequal settlement, to ligh

centers, etc., but it seems to be equally as reasonable to presume it to be caused by the expansion or contraction of the cement concrete at the joint of contact with the 4-inch brick arch, and the resulting sliding action of the cement concrete by that of the adjoining brick surface.

For a foundation, where cheapness, durability, strength, etc., are the requisites, cement concrete is an excellent material when properly made and rammed into position. Probably no branch of masonry construction requires so much painstaking care and thorough knowledge of just what is required and how to accomplish it, as the proper manipulation of cement concrete.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

AFTER an experience of more than a year in the supply of incandescent electric lighting, the rate of pay therefor being based on "what gas formerly cost the consumer," the Mount Holly (N. J.) Electric Light Company has notified its patrons that a "slight increase" in the rates for commercial lighting is to be made. The "slight increase" amounts to something like 15 per cent.

THE adjoining or neighboring town of Moorestown has also given shelter to a puny specimen of an electric lighting company, the proprietors whereof have attracted attention to themselves by ordering an advance in rates, the same to take effect on January 1st. The explanation is: "This was made necessary to properly cover the expenses of the company."

JUST think of it! Jolly and gentle "Ed." Stein languishing in the wilds of Waukegan, Ills.! Does he ever think of the flesh pots of the Quaker City? Can he ever forget them—that's more like it. Still, it is just possible that he is more to be envied than pitied; for out in that "Western fastness" is not his everlasting fortune to be made in starch? No wonder that he is stiffening up! Joking aside, we are more than pleased in this Christmas week to say that the prospects of the Company with which Mr. Stein is connected are of the brightest sort, and that its positive commercial success is assured. The following account of the Company's works is from the columns of the Waukegan *Post*: "According to the old pagan mythology one of the heroes sprang full-grown and equipped for war from the head of a goddess, and many enterprises have risen phœnix-like from the ashes of some great calamity in larger proportion and to greater successes than ever before. Something akin to this has been the manner in which the extensive starch works have risen as from the sand, in a few weeks. It seems only a few days since the workmen began the foundations, and now the walls of those large, massive, well constructed buildings are completed, and the roofs are on. There are, strictly speaking, three buildings, which we may mention in the following order. First, the large, central, 3 story one, known as the starch house, 96 by 100 feet, ground dimensions. The first story is 22 feet clear, and will be occupied by huge tanks, each 12 feet high by 13½ feet in diameter, set directly on the ground, all being connected at the top with platforms and walks. The second floor will be devoted chiefly to starch tables, while the third floor will be similarly used. Of course, there will be much machinery in these rooms, which our space will not permit us to refer to minutely. This central building is flanked with two wings. The one on the north is known as the kiln house, is 96 ft. by 100 ft. on the ground, as it is to be devoted to kilns for drying the starches as manufactured. It is 2 stories high. The south wing is known as the mill building, 64 ft. by 128 ft., having 2 full stories and a good 8-foot basement. In this building the corn will be stored and ground. The grain will be delivered from the cars, on a side track close to the building, into a pit in the basement, thence by an elevator to the third floor, which may be styled one large corn storage room. The mills for grinding will occupy the balance of this building. The walls of all these structures are 17 inches thick, placed on the best possible stone foundations. Directly east of this south wing is the engine room, 48 by 48, and 1 story high. The foundations for the engine will be about 24 by 40 feet, and laid 8 feet below the surface, going several feet down into the hard, blue clay. Immediately east of, and connected with this is the boiler house, 50 by 80 feet, in which will be placed the battery of boilers, with storage room for coal. The east fronts of the boiler and starch buildings are in line, so that one railway track passes both of them, the coal being shoveled from the cars into the boiler room. The smokestack is about 12 by 12 feet, outside, with walls 3 feet thick at the base, with a 6-foot flue, and connects directly with the boiler and engine room. The stack is 100 feet high. There are three railroad tracks, two of the E. J. & E. Company's, both on the east side of the works, and the Northwestern on the west side. This gives the starch works superior railroad facilities, as the tracks are so arranged that material can be received at any point alongside the buildings and unloaded exactly where it is wanted. In the construction of these works—and it is only since October the task was begun—nearly 2,000,000 brick were used, and 100 car loads of stone—altogether, over 600 car loads of building material were used. Over 200 men were employed on these works, and as a result of the excellent service rendered by both the Northwestern and E. J. & E. Railroads, there has not been an hours delay from waiting for material. This speaks volumes for Waukegan as a point where railroad facilities are to be considered. A large force of men are now engaged on the interior construction, and it is the intention of the officers of the Company to begin the manufacture of starch as soon as it can possibly be done. Contracts have been let for all the machinery, and several consignments of the same have already been received." From this it will be seen that Mr. Stein will likely be a very busy man in 1891; and we wish him that success which his straightforward record in connection with the gas industry entitles him.

AT the annual meeting of the Ilion and Mohawk (N. Y.) Gas Light Company the following officers were chosen for the ensuing year: President, Thomas Ringwood; Vice-President, John Hoefler; Treasurer, C. W. Carpenter; Secretary, M. J. Richards; Manager, John A. Giblin; Directors, Thomas Ringwood, M. J. Richards, F. C. Shepard, C. W. Carpenter, John Hoefler, A. N. Russel, J. V. Schmidt, E. Roche and H. D. Alexander.

THE authorities of Henderson, Ky., purchased the local gas works in 1867, and leased them for a period of 15 years, or until 1882, when they assumed direct control of their operation. In 1882 the rate charged for gas was $2.25 per 1,000, successive reductions having put the rate at this time to $1.50 per 1,000 for illuminating gas and to $1 per 1,000 for gas used for cooking, heating and power purposes. Last year the send-out amounted to 11,626,000 cubic feet, of which quantity 2,857,860 feet was consumed in the public lamps. Coal gas is manufactured, and the average illuminating value of the product distributed was 19 candles. It would appear that the works are well managed, and that the people are satisfied. The population of the place is said to be very close to 10,000.

A FRANCHISE for a gas, electric light, and water works company has been awarded to Messrs. Francis Donahoe, N. B. Coffman and J. R. Welty, by the authorities of Chehalis, Washington. Under the agreement, the electric light portion of the undertaking is to be in operation by March 10th, and the authorities agree to take, on public account, not less than 10 arc lights (2,000-candle power each), the charge for these to be $12 per month each, on an all-night table. It also agreed that private consumers are not to be charged in excess of the following rates for each 16-candle power incandescent lamp supplied: $1.25 per month, to 10 o'clock; $1.50 to midnight; $2, all night. The franchise is to live for 30 years. The authorities, however, to have the right to purchase the plant at the expiration of 20 years. The Company also binds itself to supply gas to the town "within a reasonable specified time after demanded by the Council." This place is a post town of Lewis county, Washington, and is on the Chehalis river and on the Northern Pacific Railroad at a point 30 miles south of Olympia. Coal is abundant. The population is not far from 8,000, and we have little doubt that the gas works portion of the enterprise will be gone on with before the close of 1891.

THE rates charged by the Westinghouse Company for its meters for measuring natural gas are:

Capacity, cu. ft. per hour.	Price.
30,000 to 35,000	$1,800
10,000	700
5,000	200

meter to supply a 25-horse power engine, $125; 12-horse power engine, $75; house meter, "No. 3," $20; "No. 5," $25; "No. 8," $35.

BEGINNING December 1st, the uniform rate charged by the Philadelphia (natural) Gas Company to domestic users is 15 cents, net, per 1,000 cubic feet.

JUDGE SIMONTON, at Harrisburg, Pa., before whom was argued the case of the Commonwealth of Pennsylvania against the United Gas Improvement Company, has decided in favor of the defendent. He holds that the Company cannot be held for taxes upon the proportion of its capital stock invested in patent rights granted by the Government.

THROUGH the bursting of a pipe used to convey petroleum from tank cars into the works of the Augusta (Me.) Gas Company, over 4,000 gallons of the fluid found its way into the Kennebec river.

THE Delaware County Gas Company will succeed to the franchise and works of the South Chester, Pa., Gas Company. The capital stock is put at $100,000, and the plant will be virtually rebuilt.

THE authorities of Cambridge, Mass., have decided to purchase the automatic gas lamp lighting and extinguishing devices, as per the programme arranged that was noticed in our last issue.

M. JARECKI, Light Inspector, Denver, Col., at the solicitation of Mayor Londoner, has presented the following estimate of the number and cost of the lights (electric) that will be required to light the streets and public buildings of Denver in 1891:

600 all-night arcs, at $120 per year	$72,000
1,600 incandescents, at $26 "	41,600
46 tower arcs, at $216 "	9,936
Various buildings	5,000
Inspector's salary	1,800
Total	$130,336

THE following are the bids submitted by the respective competitors in competition for the public electric lighting of Davenport, Iowa, the figures being submitted in response to the invitation for such tenders from the Committee on Light, of Councils:

Peoples Light and Fuel Company, not less than 150 arcs (2,000-candle power) on a 3-year contract, $98 per lamp; 5 years, $89; 7 years, $85; 300 incandescent lamps (32-candle power each), 3-year contract, $27; 5-year, $25; 7-year, $23.

Electric Illuminating Company, 100 arcs (2,000-candle), 3-year contract, $85; 5-year, $83; 7-year, $81; 300 incandescent lamps (32-candle), 3-year, $21; 5-year, $20; 7-year, $19.

Thomson-Houston Electric Company, 100 arcs (2,000 candle), 3-year, $100; 5-year, $90; 7-year, $80.

Davenport Gas Light Company, 100 arcs (2,000-candle), 3-year, $95; 5-year, $90; 7-year, 85.

THE Village Electric, Gas Light and Railway Company has been incorporated by Messrs. Wm. H. Porter, Chas. S. Read and Gilbert E. Porter. It is capitalized in $50,000, and the articles assert that the desire of the proprietors is to construct electric and gas plants and to furnish gas and electricity for illumination and power in Du Page county, Ills.

THE "independent" politicians of Jefferson county, Ky., and more particularly those resident in that county's beautiful and progressive city of Louisville, have, in season and out of season, been most violent in their attacks on the management of the Louisville Gas Company; and these sons of toil(?) are not over-particular in the nature of what they charge against the management. Such delicate thrusts as those contained in the words perjurers, vote-purchasers, bribers, etc., are of loud and frequent flaunting by the miserable crew, who never having had anything of their own to manage, insist that able business success must be grounded on fraud and nurtured on robbery. Hitherto the proprietors of the Louisville Company have kept on in the even tenor of their way, attending to their own affairs, and reaping substantial reward from the skill and courage that they have displayed in their management, unmindful of the snarling pack whose yelping ought to be rewarded by the contempt of inattention. And we are sorry that the Louisville Company has seen fit to depart from its hitherto well-kept-up policy of dignified silence. Apparently having lost control of its temper, the Company, at a meeting held on the 8th inst., caused the adoption of the following resolutions, which are reprinted without further comment at our hands, save that we would be better pleased to know that such action had never been taken:

OFFICE LOUISVILLE GAS COMPANY,
LOUISVILLE, KY., Dec. 9, 1890.

At a regular meeting of the Board of Directors of this Company, held on the 8th inst., on motion of John M. Robinson, the following preamble and resolutions were unanimously adopted, to wit:

Whereas, During the recent municipal election there appeared at divers times statements in some of the public prints of this city to the effect that this Company had contributed money for election purposes, which, if believed, reflects upon the personal integrity of this Board of Directors, as it implies a perversion of the funds of this Company, and a violation of the trust reposed in us; therefore be it

Resolved, That this Board officially declares that all statements or intimations that this Company has in any way directly or indirectly contributed one cent for political purposes of any character are totally untrue, without foundation in fact or intention.

Resolved, That the President be requested to give such publication of this action as he may deem necessary.

By order of the Board, GEO. W. MORRIS, President
E. S. PORTER, Secretary.

A DAMAGE case that attracted much attention in Boston, Mass., early this month, was that of Gertrude McNeal against the Boston Gas Light Company. Plaintiff, who is perhaps 19 years of age, asked for $30,000 damages for personal injuries caused by the neglect of the defendant's agents. According to the testimony, plaintiff was employed by a firm who occupied the second floor of the premises on the northeast corner of Washington street and Indiana place, that on the afternoon of Sept. 18, 1889, she had occasion, in the performance of her work, to cross from one room on the floor to another, and that in so doing she fell through a trap-door that had been opened by workmen in the employ of the Boston Gas Light Company for the purpose of permitting them to carry on with greater ease the inspection of certain pipes and a gas meter. The defendant interposed the defence of contributory negligence. The case was tried in the Superior Court, before a jury, and the hearing occupied a week, but despite all the ingenuity and pleading of the Company's counsel—Messrs. A. A. Strout, C. P. Greenough and J. P. Parmenter—whose arguments were cleverly and concisely put, the jury, after some deliberation, returned a verdict in favor of plaintiff for $9,000. It was conclusively shown that plaintiff's injuries are permanent. Mr. Thomas Riley conducted the case for plaintiff.

CONTRACTORS might do well to bear in mind that the works of the Northampton (Mass.) Gas Company will be materially enlarged next spring.

THE property of the old Willimantic (Conn.) Gas Company is now in possession of the incorporators of the Citizens Gas Light Company, of that city, and contracts have been given out for the installation of a water gas plant. We understand that the new construction will be completed by March 1st, and that the cost of the same will approximate to, if not exceed, $25,000. In the meantime the main system changes and extensions are being sent along with despatch. A most hopeful sign in the method adopted is the determination that "dead ends" in the circuit shall no longer be of record on the maps of the Company.

THE regular semi-annual dividend of 3½ per cent. on the shares of the Brookline (Mass.) Gas Light Company has been declared, payable on demand on and after January 15, 1891.

MR. A. P. SHAWVER, City Civil Engineer of Indianapolis, Ind., has been authorized to ask for tenders for supplying arc lights to the city, the competition to terminate on January 5, 1891. The following are the main points of the specification:

"Propositions to be for 100 lights, for 500 lights, for 600 lights, for 700 lights and for 800 lights, all to be 2,000-standard candle power lights, suspended on mast arms. All bids to be made to comply with provisions of General Ordinance No. 44, 1888, of this city, providing for the placing of all electric light wires within North, South, East and West streets, to be laid underground, outside of which boundaries wires may be strung on poles. The contractor to furnish all necessary material, and do all work of whatever kind necessary to construct, equip and maintain in good and substantial electric installation, complete and ready for operation for lighting the city, and when the same is completed shall operate the same in its entirety for a trial period of 60 days. The lights furnished shall be as good as the best standard 2,000-candle power lights used in any city in the United States. At the end of the trial period, if the lights are as good as above specified, and should the performance of the entire plant prove satisfactory, the city will accept the same, and the rental shall date from the beginning of the trial period. But should the performance of the entire plant be not satisfactory to said city, the plant will not be accepted, and no rent will be paid until said plant is made, in its entirety, perfectly satisfactory to said city. The equipment must in all respects be of the best manufacture and of the latest and most approved design. Bidders to make their propositions upon the basis of an all-night lighting schedule, beginning one-half hour after sunset and ending one-half hour before sunrise; also, on a basis of a 5-year and also on a 10-year contract. Lights to be located under the direction of the Committee on Public Light, of the Common Council, and Board of Aldermen and the City Civil Engineer. The plant will consist of an equipment capable of operating and sustaining circuits upon which to operate arc lights of

2,000 standard candle power each. Not more than 50 lamps to be lighted by any one circuit. The mean photometric candle power of the lights, measured at an angle 45° from a horozontal, shall be as great as that shown by the best standard 2,000 candle power arc light now in use in the United States," etc.

THE Enginer also asks for tenders for 500, 1,000, 2,000, 3,000 or 4,000 gas lamps, of the capacity and sort now in use by the city.

A LOCAL authority, in commenting on the public lighting situation at Allegheny City, Pa., says that on January 16 the city will be called upon to accept the electric light plant from the contractors, whereas the action that is to be taken in the matter is very far from having been settled upon. Councilman Roudolph, of the Fifth Ward, is very outspoken in his condemnation of the system and its cost, and he brings forward figures showing that at the present rate of expenditure it will require $100,000 per annum to operate the plant. The towers, too, are a dismal failure; and, take it all in all, the plight of the city in respect to the outcome of its lighting venture on municipal account is not a happy one. The contractors, however, show no symptoms of uneasiness, and rest content in the knowledge that, as their part of the task was performed according to the strict letter of the specifications, and as the city is solvent, they will be paid in full.

A ROCHESTER (N. Y.) correspondent humorously asserts that the inhabitants of the adjoining town of Attica have become tired of acting as public lamps (they depend on "individual" lanterns to light them on their way), and the authorities will now invite proposals for a public lighting system.

IT is said that Boston parties are considering the advisability of putting in a gas and electric light plant at Stratford, Conn.

THE beginning of the end would seem to be indicated in the financial peddling that is now going on in the Westinghouse Electric Company. Whether so or not, the following inclosure from a Pittsburgh correspondent affords much food for reflection: "The stockholders of the Westinghouse Electric Company met in Philadelphia on the 10th inst., and decided to issue $3,000,000 of preferred stock. Having called the meeting to order, President Westinghouse submitted a statement respecting the Company, the statement being based on figures compiled by a committee appointed to examine the Company's affairs. The report put the assets at $6,280,000, and the liabilities at $3,642,045.97. Mr. Westinghouse then explained the necessity for issuing $3,000,000 preferred stock with par value $50 a share, bearing 6 per cent. interest, this stock to have first claim on the assets of the Company. Mr. Westinghouse also put forth argument where it would be possible to wipe out about $1,500,000 of the liabilities (in all probability this one and a half millions is the debt of the Company to him), 'thus placing,' as he said, 'the Company on a solid cash business.' He said the money derived from the sale of the preferred stock would serve to "pull the Company through the present stagnant state of business." The capital stock of the Company is $10,000,000, and it was almost unanimously voted to issue the $3,000,000 of preferred stock, the new issue to be registered—in fact, to a tyro, the new issue looks suspiciously like a first mortgage bond. The report of the number of stations and lights controlled by the Company was as follows: Number of central stations, direct current arc, 71. Number of central stations, alternating current arc, 66. Number of central stations, incandescent, 357. Number of central stations that have increased their capacity since they started—arc type, 17; incandescent, 101. Total light capacity, direct current arc, 5,280; alternating current arc, 5,510; incandescent, 651,300. Number of street car motors, 407.

THE Council of Columbia, South Carolina, have awarded a contract for the public lighting of that place, by electricity, to the Congaree Gas and Electric Light Company, the agreement to last for two years from January 1, 1891. Arcs are to cost $132 each per annum; incandescents (20-candle power), $21 each.

SUPERINTENDENT HADLEY, of the Meriden (Conn.) Gas Light Company, received a call the other day from a well-dressed man who said that a stout man was waiting on the sidewalk for the Superintendent. The latter locked the safe, tried the money drawer and accompanied the "well-dressed" down the stairs. The stout man was not visible, and the Superintendent stepped into the store underneath the office, presuming that his "stoutness" was there in waiting—in the meantime the "well-dressed" had sauntered off. The stout party not being discoverable, Mr. Hadley ascended to his sanctum, there to find an "aching void" in the money drawer, which had been forced open and the contents removed.

JOHN LYON, an employee of the Portchester (N. Y.) Gas Company, lost his life through a gas explosion that occurred there a few days ago.

THE American Automatic Gas Machine Company has been incorporated at Camden, N. J., with a capital of $250,000. The incorporators are Messrs. Lyman B. Childs, Oscar S. Wilson, Edwin Paramore and Heister Brimmer, of Philadelphia, and Harry H. Copeland, of Camden.

ON and after January 1, 1891, the Directors of the Wooster (Ohio) Gas Light Company have decided that the following gas rates shall rule:

Quantity Used Monthly.	Net Rate per M.
100 to 1,000 cu. ft.	$1 40
1,000 to 5,000 "	1 35
5,000 to 8,000 "	1 30
8,000 and upward	1 25

The Company also agrees to furnish pipe and fixtures at cost, and to keep all burners in repair without charge; further, that the best makes of gas cooking and heating stoves will be supplied on demand, at factory prices. Our correspondent who furnished us with the official notification of the Company's action ventured the query, "How's this?" To which we reply, "It is simply splendid," and that the Messrs. Kauke can be depended on to keep Wooster up in the front rank, so far as intelligent and liberal management of its gas interests can contribute to so desirable a policy.

MR. A. F. GILBERT is looking over the situation at Fairbury, Neb., with a view to erecting a gas works there.

Carbon an Impurity in Hydrogen Affecting Determination in Atomic Weight.

Prof. E. W. Morley, notes that it is very difficult to obtain hydrogen free from carbon if zinc is employed.

1. If zinc be dissolved in dilute acids, carbon contaminates the escaping hydrogen. No sample of zinc yet obtained by the writer gave hydrogen in which carbon was not quickly shown by passing it over heated copper oxide and into lime water.

2. If zinc be amalgamated, put into dilute acid and hydrogen obtained electrolytically, it still contains carbon, which has been proved in the same way.

3. If the purest zinc obtainable in commerce is heated in a vacuum, it gives off a gas containing carbon not in the form of the dioxide. Dr. Wm H. Burton kindly made many experiments on this matter; sixty grammes of zinc gave sometimes 0.8 c. c. carbon dioxide by combustion of carbon existing in the gas given off on fusion in some form other than carbon dioxide. All samples also gave off nitrogen.

4. It is obvious that metallic aluminum is likely to contain gases imprisoned in it and derived from metallurgical processes.

5. The electrolysis of an alkaline hydroxide is likely to give an impure hydrogen unless alkaline carbonates be removed. Such electrolysis, where a carbonate had been purposely added, in a voltameter most thoroughly cleaned from all organic matter, gave hydrogen containing a notable amount of carbon.

The bearing of these facts on the determination of the atomic weight of hydrogen is obvious.

The Market for Gas Securities.

An easier money market and a renewed attack on floating shares by investors led to better prices all round in the share market during the past week, and in common with the rest gas shares advanced noticeably, although the net increase in values for the week was not so pronounced as we presumed would be recorded. Consolidated made and held an advance of 3 points, opening sales to-day (Friday) being made at 91¾. Something like 1,500 shares of Consolidated were taken during the week for investment from what might be called "street stock," and it is a patent fact that the volume of such floating stock is shrinking rapidly. The inevitable result must ensue—a decided and permanent rise in value.

The Equitable Company suffered a severe loss last week in the death of President Graham, but no depression was caused in the shares, which are firmly held. In Brooklyn shares the tendency seems to be all in favor of higher prices, and Nassau gas appears to be most in favor. Bay State gas is higher, and Laclede gas made an important movement upward on the receipt of the decision of the Supreme Court that the 90 cent gas ordinance was invalid.

THE AMERICAN GAS LIGHT JOURNAL

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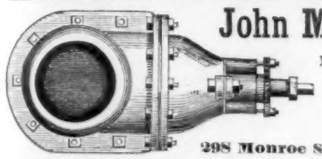

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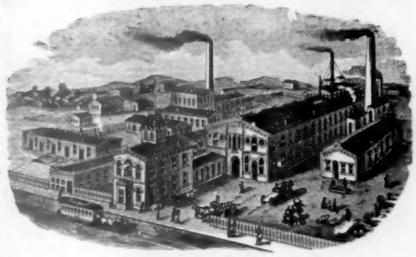

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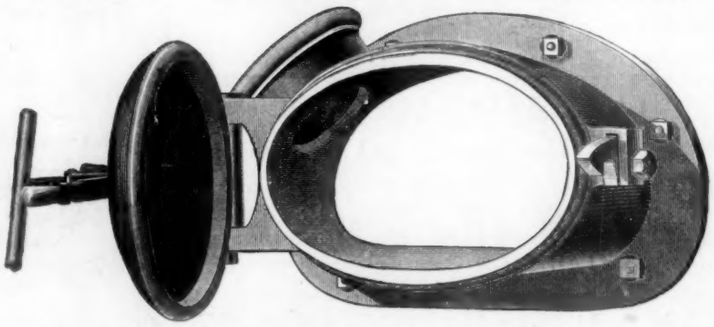

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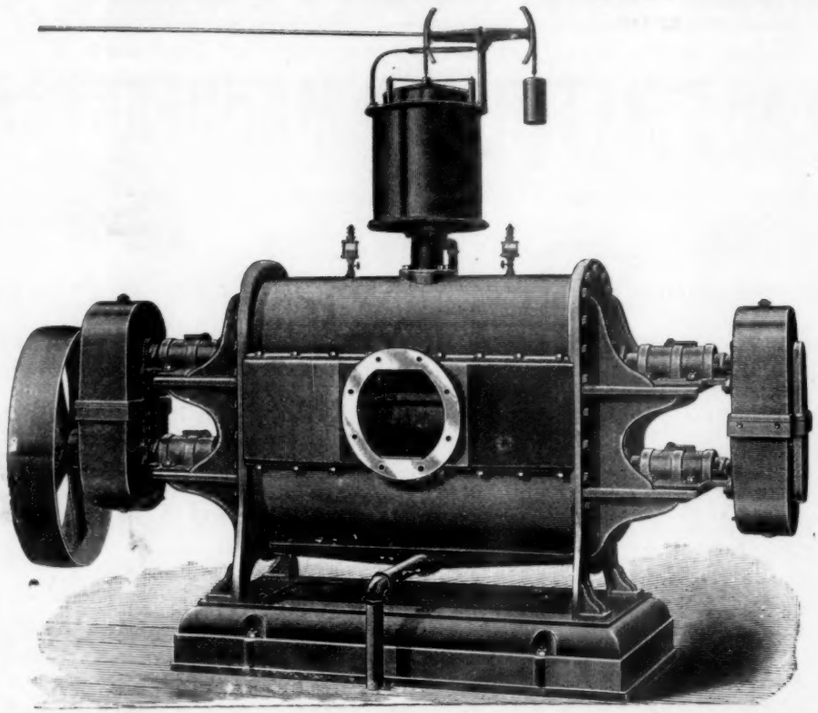

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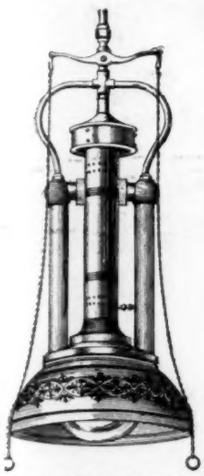

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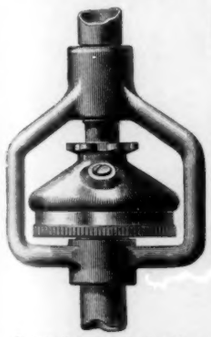

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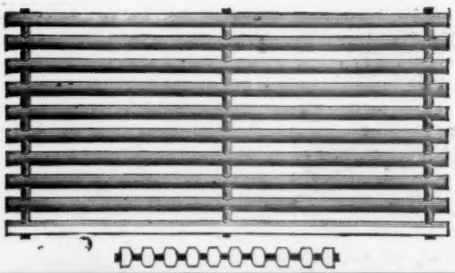

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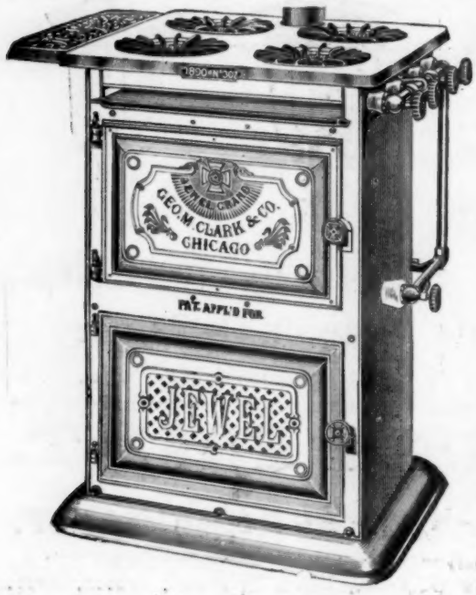

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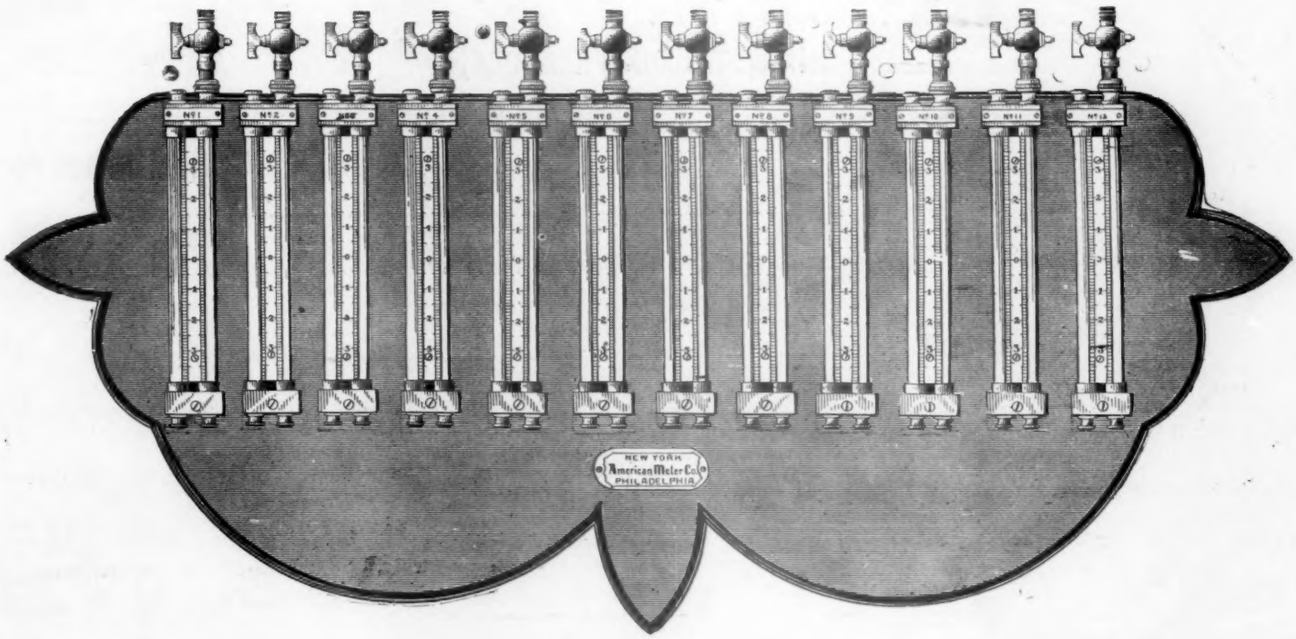

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MINIMUM WEIGHT IN MOTION,
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WITH MAXIMUM RESULTS.

396 "Standards" are now in use throughout the World, and a large percentage of these are in the United States.

The "New" Washer-Scrubber, with Wooden "Bundles," has been for many months in successful operation at the London Gas Light and Coke Company's station at Beckton (*vide* testimonial).

THE GAS LIGHT AND COKE COMPANY, HORSEFERRY ROAD, WESTMINSTER, Nov. 25, 1889.

MESSRS. KIRKHAM, HULETT & CHANDLER, LIMITED:

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I am yours truly, (Signed) G. C. TREWBY.

THE "BUNDLES" CAN BE SUPPLIED TO "STANDARD" WASHER-SCRUBBERS ALREADY IN USE.

NOTE.—The first Washer-Scrubber referred to in the above letter was fitted with improved "Bundles" in May, 1888, and these have proved so satisfactory that the Gas Light and Coke Company have had several other "Standards" fitted in the same manner, and have recently given an order for machines for 6,000,000 cu. ft. per day.

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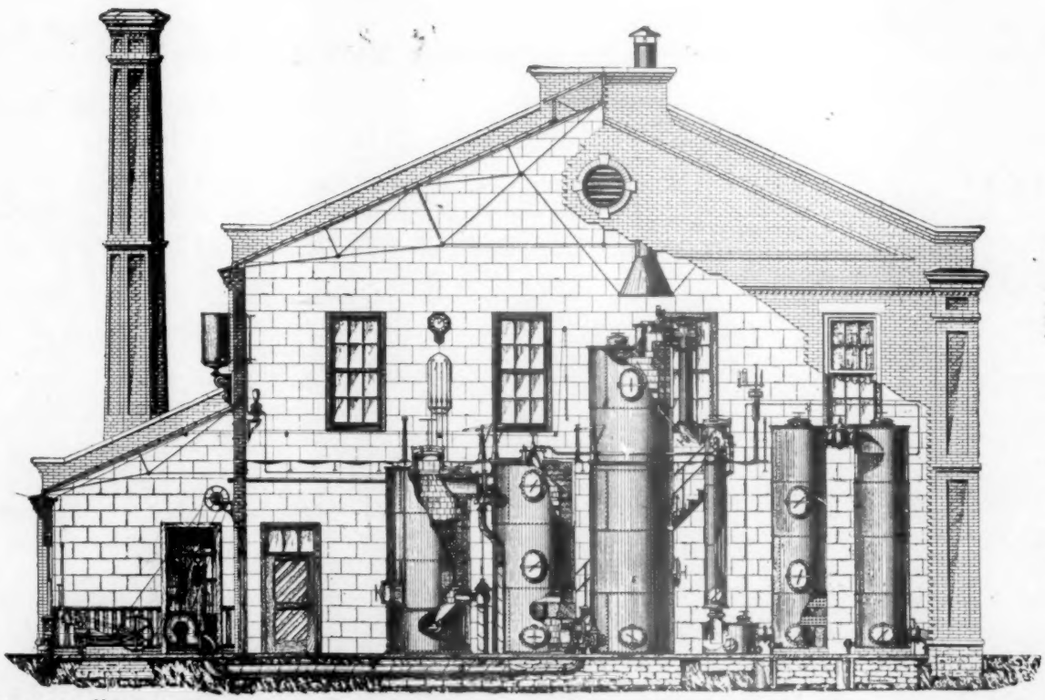

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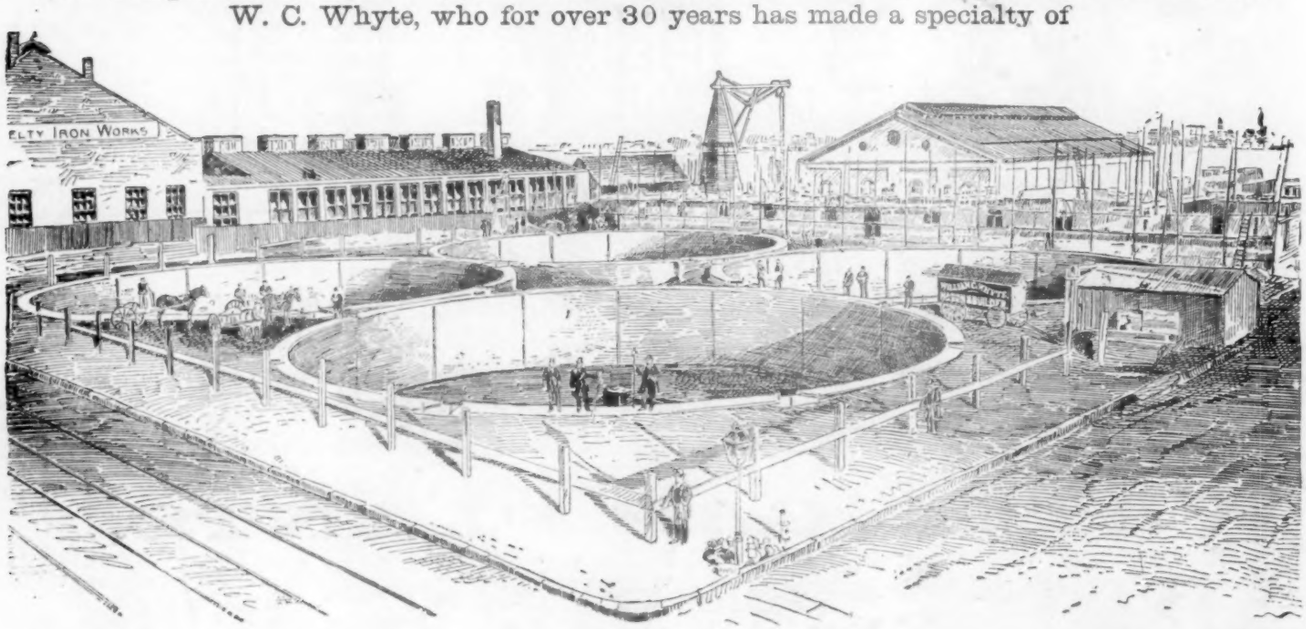

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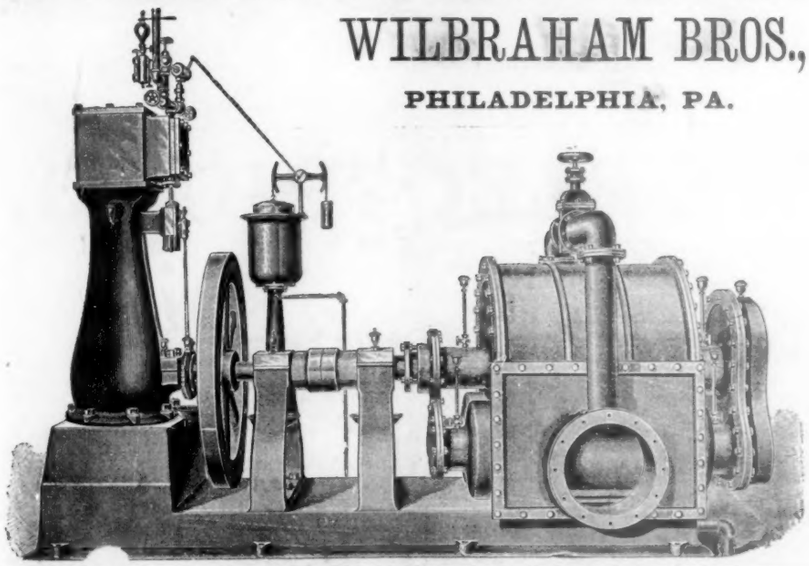

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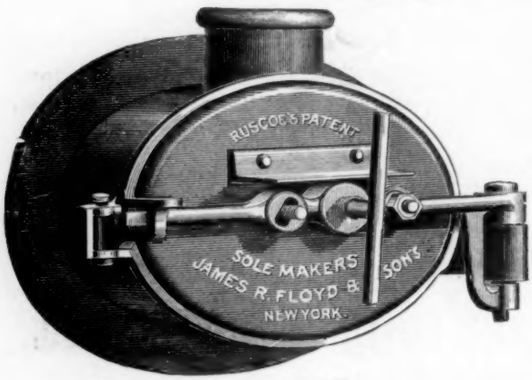

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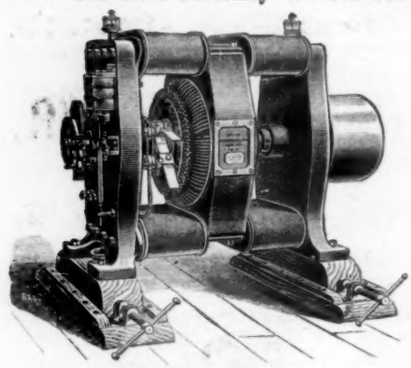

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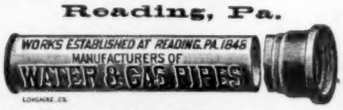

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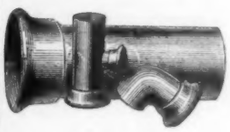

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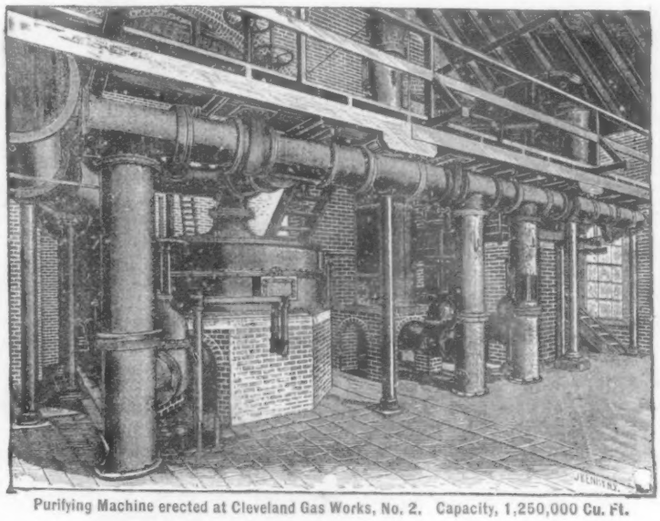

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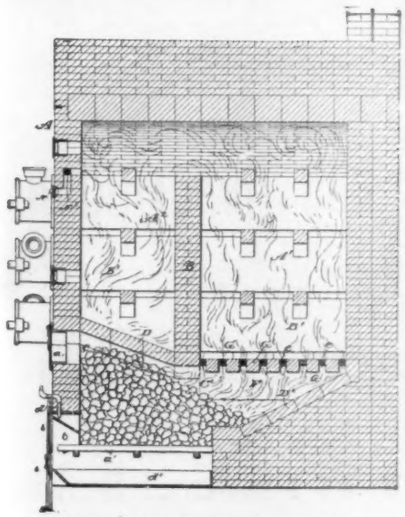

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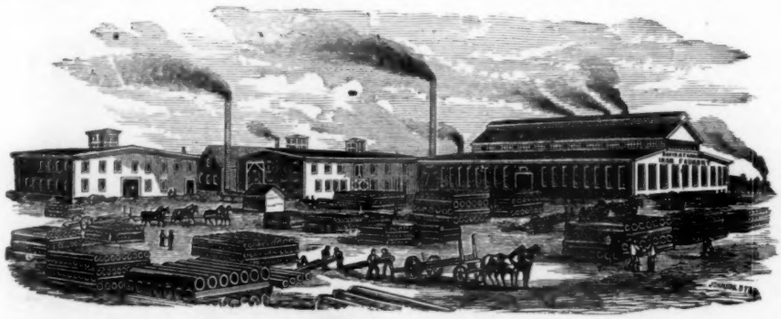

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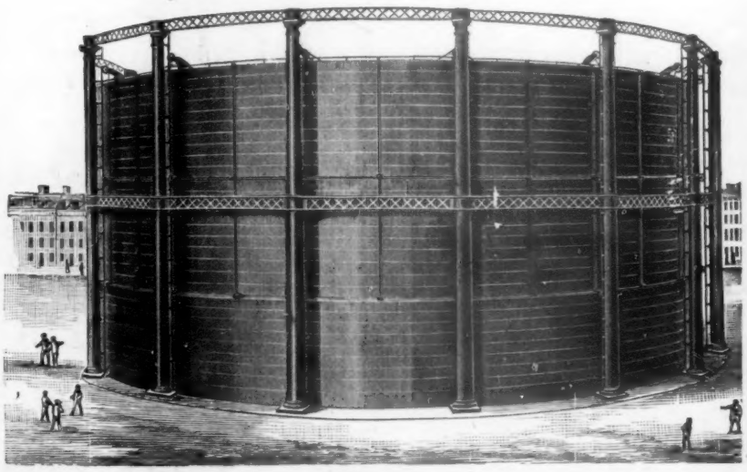

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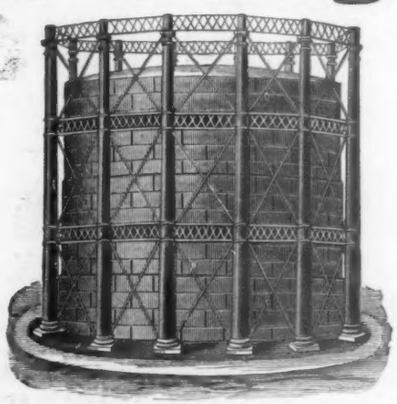

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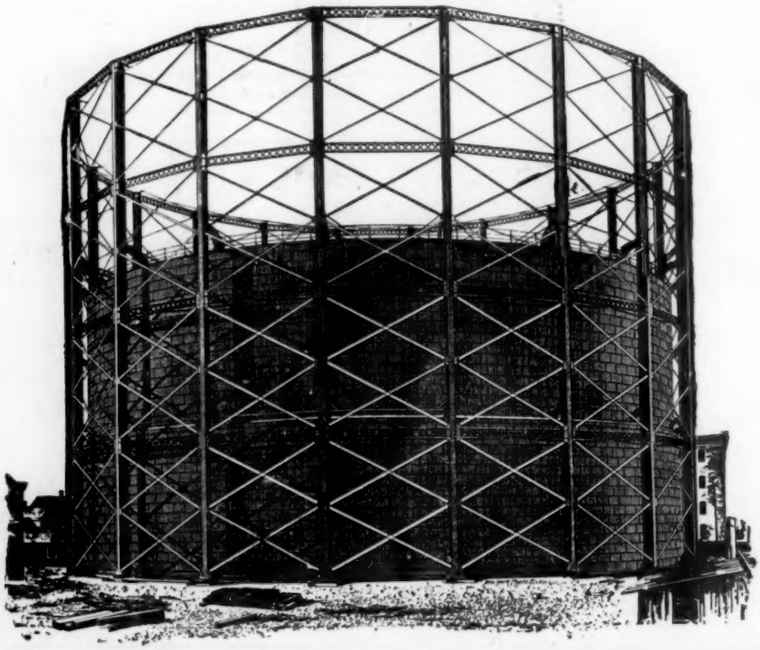

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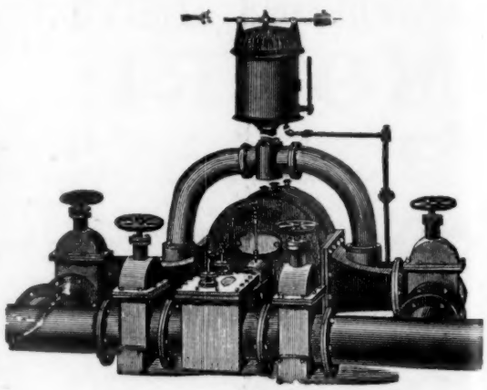

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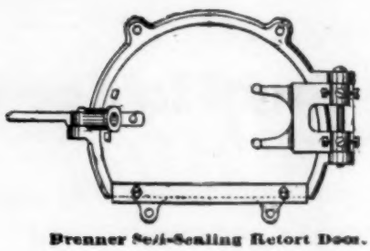

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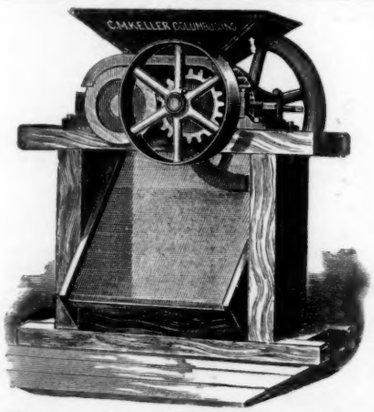

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WET AND DRY GAS METERS. STATION METERS, EXPERIMENTAL METERS, METER PROVERS,

Center Seals, Pressure Registers, Governors, Indicators, Photometers, and all other kinds of Apparatus for use in Gas Works.

FOULIS' PATENT STATION AND DISTRICT GOVERNORS.

REPAIRING DEPARTMENT.—We employ a special force of skilled workmen repairing meters of **all makers.**

WM. WALLACE GOODWIN, President and Treasurer. E. STEIN, Vice-President. H. B. GOODWIN, Secretary and Superintendent.

THE GOODWIN GAS STOVE AND METER CO.,

Successors to W. W. GOODWIN & CO.

1012, 1014 & 1016 Filbert St., Phila., Pa. 113 Chambers St., N. Y. City. 44 & 46 Dearborn St., Chicago, Ills.

WALDO BROTHERS, Agents, 88 Water Streets, Boston, Mass.

MANUFACTURERS OF

DRY AND WET GAS METERS,

Station Meters (square, cylindrical, or in staves), Glazed Meters, King's and Sugg's Experimental Meters, Lamp Post Meters, etc., etc. Meter Provers (sizes 2, 5, and 10 feet), Pressure Gauges of all kinds, Pressure Registers, Pressure and Vacuum Registers, Pressure Indicators (sizes 4, 6, and 9 inch), King's Pressure and Vacuum Gauges, Dry and Wet Center Seals, Dry and Wet Governors, Exhauster Governors, Photometers of all descriptions. Letheby's Sulphur and Ammonia Test Apparatus complete. Also, Testing and Chemical Apparatus of all kinds, and of the most perfect description, for all purposes relating to Gas.

Manufacturers of the "SUN DIAL" GAS STOVES, for Cooking and Heating.

Goodwin's Improved Lowe's Jet Photometer. **Agents for Bray's Patent Gas Burners and Lanterns.**

Special attention to Repairs of Meters and all Apparatus connected with the business. All work guaranteed first-class in every particular. Orders filled promptly.

G. B. EDWARDS, Manager, New York. **S. S. STRATTON, Manager, Chicago.**

D. McDONALD & CO.,

GAS METER MANUFACTURERS.

(Established 1854.)

51 Lancaster St., Albany, N. Y. 34 & 36 West Monroe St., Chicago, Ill.

STATION METERS, EXPERIMENTAL METERS, METER PROVERS, PRESSURE & VACUUM REGISTERS, PRESSURE GAUGES, ETC.

Also STAR GAS STOVES, RANGES, and HEATING STOVES.

We use only the very best materials, and employ the most skilled labor, and by our long experience (36 years) and personal supervision of every detail, we feel justified in assuring the public that our goods will give perfect satisfaction. Every Meter emanating from our establishment will bear the State Inspector's Badge, and will be fully warranted by us. Our Annual and Calendar will be sent to Gas Companie upon application.

WM. WALLACE GOODWIN, President. E. STEIN, Vice-President. H. B. GOODWIN, Sec. & Supt. G. B. EDWARDS, Mang'r, New York. S. S. STRATTON, Mang'r, Chicago.

THE GOODWIN GAS STOVE AND METER CO.,

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Agents, WALDO BROTHERS, 88 Water Street, Boston.

SOLE MANUFACTURERS OF THE

"SUN DIAL" GAS STOVES,

The Most Economical, Efficient, and Durable Gas Stove Made.

GAS COOKING STOVE, No. 8 C.

SIZE.

Stove.	Oven.	Roaster.	Top.	Length over Extension Shelves.
37 in. high.	12 in. high.	12 in. high.	24 in. long.	36 in.
20 in. wide.	17½ in. wide.	18 in. wide.	21 in. wide.	
	12 in. deep.	13 in. deep.		

This Stove has four burners on top, and double oven burner.

Consumption of gas with all burners in use, 42 feet per hour, at 1 inch pressure.

The top is made in sections, so that a greater variety of cooking utensils may be used. By lifting out the covers and crosspieces and putting in a suitable forked ring, which is sent with each stove, a wash boiler or other large utensil may be set over two burners. Our **No. 87 GRIDDLE** also fits in the same position. The roasting oven is provided with a cast-iron door.

All Fittings are Nickel-Plated.

GAS COOKING STOVE, No. 7 B.

SIZE.

Stove.	Oven.	Roaster.	Top.	Length over Extension Shelves.
31 in. high.	9½ in. high.	10 in. high.	21 in. long.	32 in.
17 in. wide.	14½ in. wide.	15 in. wide.	16 in. wide.	
	12 in. deep.	13 in. deep		

This Stove has three boiling burners in the Top or Hot Plate, and one single oven burner.

This cut represents our New Style Cooking Stove. As will be seen, it has an ornamented cast-iron Base and Front, and extension shelves. The Oven Burner, which is atmospheric (unless otherwise ordered), is of an entirely new and improved pattern (patent). The ovens are of greater capacity than those of the old style. The Top, in conjunction with the Outlet Pipe, is designed to carry off all the products of combustion, if desired, but they are also supplied with a loose ring which converts it into an ordinary open top stove.

The consumption of this Stove is 35 cubic feet per hour at 1 inch pressure, with all Burners in use.

All Fittings are Nickel-Plated.

"RADIANT" BOILING STOVE, WITH REGENERATIVE BURNER.

Size, 6½ inches diameter, 8 inches high. Consumption, 6 feet per hour at 1 in. pressure.

HOT PLATE, No. 111.

Size, 36 in. long, 12 in. wide, with three double burners, 6 taps.

Consumption, with all burners in use, 36 cubic feet per hour, with 1 in. pressure.

¾ in. supply pipe should be used where the pressure is 1 in. or over.